DECEMBER, 1933

Engineering and Mining Journal

WITH WHICH IS CONSOLIDATED ENGINEERING & MINING WORLD

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NEW YORK LONDON

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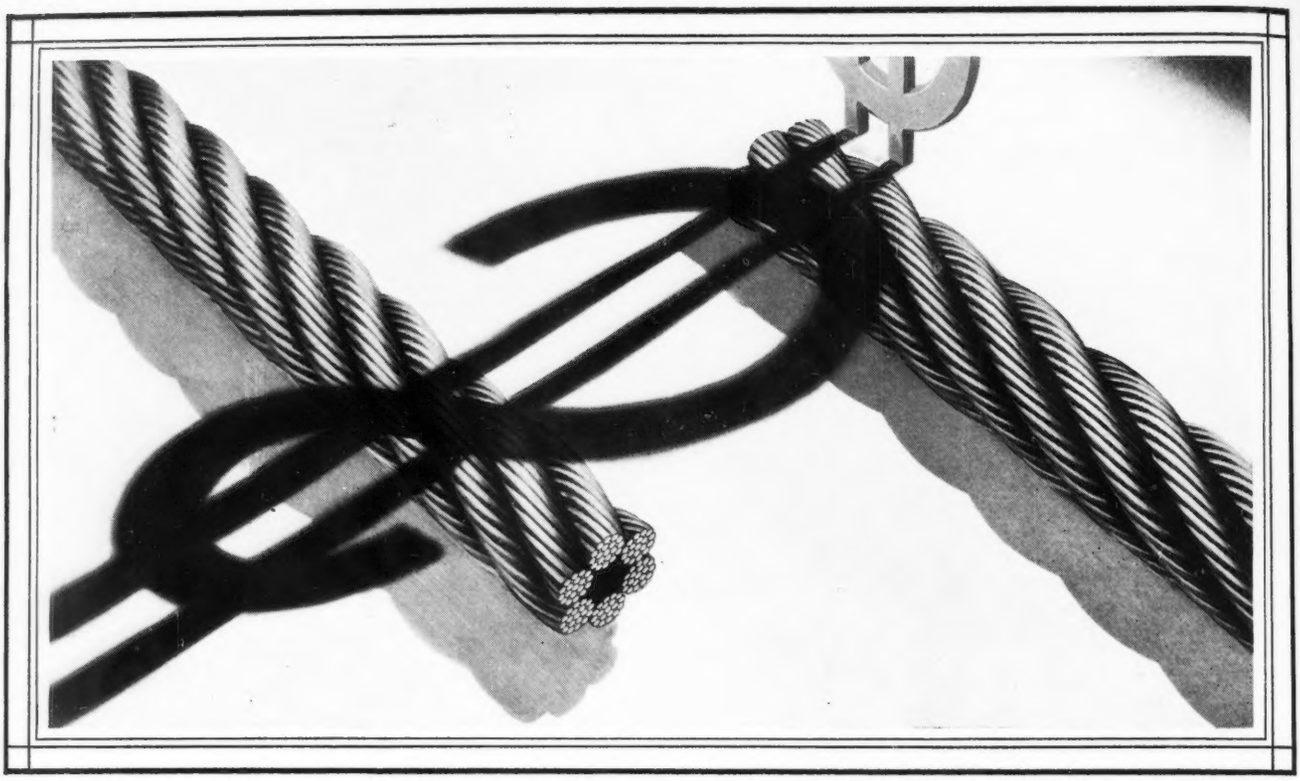

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"IT'S ALWAYS FAIR WEATHER"

WITH SUCH GOOD REASONS for being joyful this Christmas, we don't feel like using this space to talk about Bear Brand Xanthates. So we're just saying *"Prosit!"* and hoping everybody in the mining world has as good a holiday and as prosperous a New Year as we are looking forward to.

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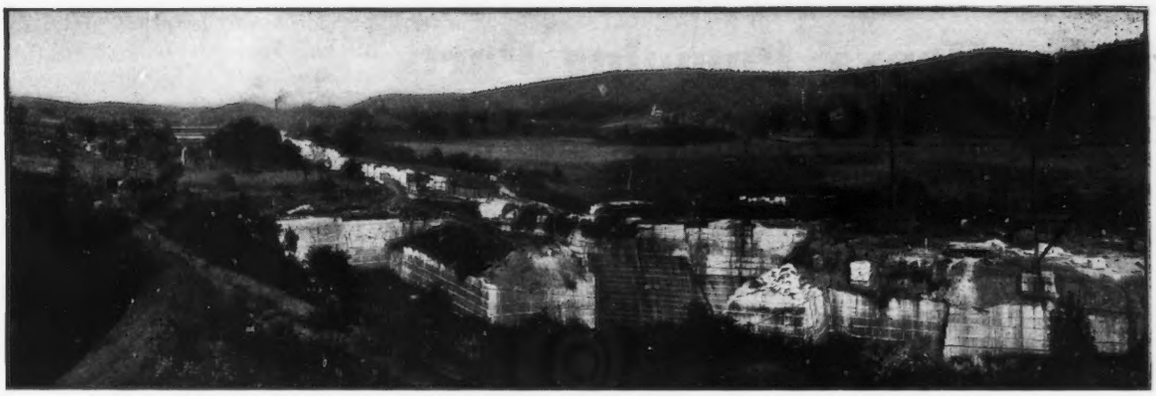
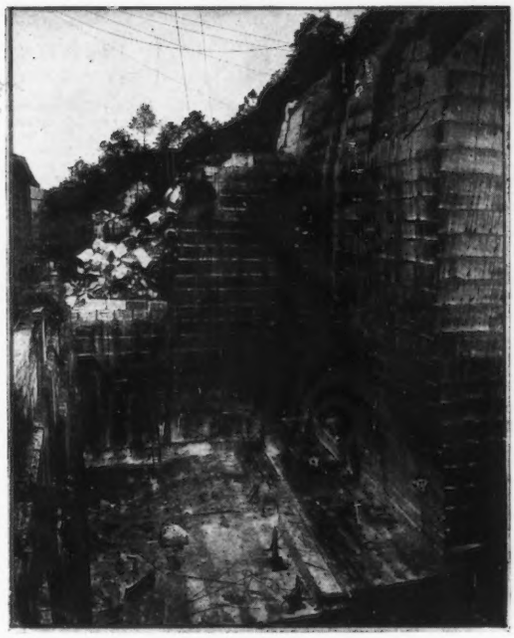


to quarry Georgia Marble



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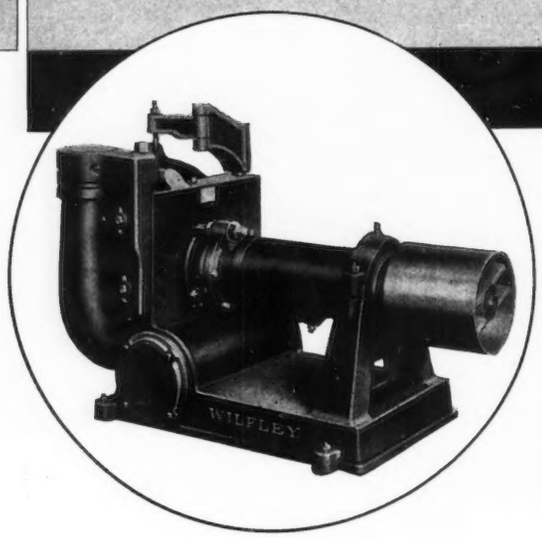

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Engineering and Mining Journal

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H. C. PARMELEE *Editorial Director*

DECEMBER, 1933

Are There Flaws in The Blue-Sky Law?

NOW that the National Securities Act has been part of the law of the land for the past five months, question as to the degree of its effectiveness may properly be raised. Is it a law that will curb the crooked capitalist and promoter, big and little, and at the same time place no obstacles in the way of legitimate financing, wherein a fair deal is contemplated for even the small fry among the security holders? Or is it so defective that amendment or rewriting is desirable? No right-thinking person who has the future welfare of the United States at heart will want it abolished, without an effective substitute. The bleeding of the resources of the many into the pockets of the few has been too ghastly for the nation to scrap this piece of blue-sky legislation because of possible imperfections. With its enactment was taken a step long wished for by many who admittedly could not see just what form desirable legislation of this kind should take. All things considered, the law is an experiment and as such can be modified, until at last something is found that will be fair to capitalist and promoter, assuring to the investor, and conducive to the development of industry.

To curb fraudulent promoters is the prime objective of the Act. Their operations have already been made more difficult. But evidence exists that these individuals, in so far as they turn their attention to mines and mining, are still practicing and have already devised what seem to be evasions and circumventions of the law. Perchance in the few months elapsed since the law became effective, the Government has not had time to act. Meanwhile they ply their trade. Their tricks vary: the gift of stock that turns out to be assessable; the broadcasting of sales propaganda by radio from Mexico, with the offer of free shares to anyone who will supply names of other prospects, the "free" certificates, however, being loaded with transfer charges that equal or exceed their worth; and more or less barefaced use of tipster sheets, or their equivalent, to effect sales from points within the country. Curiously, such sheets are said to have almost disappeared immediately after the Act became effective, but now, as the promoter's courage grows, they reappear, in conjunction with various elaborate schemes to evade responsibility. If these devices can survive a test in court, the law has loopholes.

More serious, if true as alleged by some, is the charge that the law, in its requirements as to assumption of responsibility by principals and their advisers, including engineers, is actually making capital afraid to undertake normal financing operations. This, it is said, will affect not only new ventures but also the refunding of long-term obligations. What director, asks one prominent mining executive, will sign the registration statement, when with the best intentions he cannot possibly vouch for the accuracy of all facts involved? The result will be to slow down recovery, this man fears, especially of the capital-goods industries, because many replacement programs call for new financing or refunding.

Whether the courts will hold an engineer responsible for erroneous opinion, if he has made honest statement of the basic facts, is doubtful. The question will remain until a test case arises. But it is also doubtful that any engineer is actually turning down business offered him because of apprehension of the law. Here, however, one should note, the less conservative the engineer, the less likely he will be to be deterred by the provisions of the Act. A possible effect of the law may be to incline the promoter to seek the services of reputable engineers to a greater extent than hitherto.

Liberalization of the law sufficient to remove the objections cited, yet retaining the provisions that protect the public, is entirely feasible, in the opinion of executives and engineers consulted. Indeed, the degree of protection afforded might even be increased. For example (as one engineer suggests), instead of permitting the issuer of new securities to file a balance sheet certified by a public accountant who is employed and remunerated by the former, the law might provide for the conduct of the audit by a stockholders' committee, as commonly done in Great Britain.

Whither Goeth the Gold-Mining Industry?

FROM the various gold-mining centers of the United States come reports of a steadily increasing number of new projects, including the reopening of many old properties. Most of these ventures, however, are relatively small-scale operations, and, notwithstanding the currently high price fixed by the Reconstruction Finance Corporation for newly mined gold, little substantial expansion in gold-mining activity is probable so long as the monetary program of the government is not definitely determined and publicly announced. Besides uncertainty concerning the value of his product, the gold miner, particularly the small-scale marginal producer, must expect to feel the pressure of increased costs as commodity prices rise in accordance with the very plan that is providing the higher value for his product. On this race between value of product and operating costs rests the life of

many a gold-mining venture that has come into being during the last few months.

With the recent steadiness in the R.F.C. price for gold, much of the "boom" talk in connection with the metal and its prospects has disappeared. The fact remains, however, that within the last month the price of gold advanced more than $1.50, or about 5 per cent, which compares with a 2 per cent advance in October, and one of about 50 per cent in September. Such fluctuations do not tend toward stability of the industry; instead they encourage speculation and the investment of capital in high-cost properties that may be forced to close down under stabilized conditions, with attendant loss of much of the funds invested. The larger mining companies are also faced with perplexing problems, but the general attitude on the part of such interests seems to be to calmly "ride out" the storm of uncertainty, rather than to force production and dispose of metal assets under current conditions. So, at the beginning of the fourth month of vicissitude, gold mining, the industry apparently providing at the moment the principal instrument in effecting the New Deal, would seem to have become the most uncertain of industries, from being the most favored of less than a month ago, and the all but forgotten industry, to go back only three months, when $20.67 was the prevailing price for an ounce of gold, despite a substantially higher world price for the metal.

To the investor in gold-mining securities, the situation also presents unusual difficulties, for in the past he was accustomed to appraise the profit-yielding possibilities of a company without the necessity of considering fluctuations in the price of the metal.

Industrial Uses for Precious Metals

THE high price of gold that has prevailed in recent months apparently has not discouraged all research effort directed toward the discovery of additional industrial uses for the metal. Mr. Everard Digby, for instance, is reported to have found a new use for it, following investigations that sought absolute permanency for pictorial and typographical records. Organic and inorganic substances, elements or compounds, were all found subject to decay or chemical action except gold and metals of the platinum group. A photographic technique was then developed whereby pictures and letterpress and ornamentation may be permanently imprinted in platinum on a sheet of gold, assaying about 700 fine. Thickness of sheet used is about 0.004 inch. The halftone impression and the type characters are reproduced in polished platinum on a background of dull platinum, providing pleasing and adequate contrast. Additional pictorial effect is secured by surrounding this with margins of polished gold.

South Africa House, London, is to have one of the earliest exhibits of this new development in reproduction, in the form of a plaque on which will be printed King George's address at the recent opening ceremonies, with the royal arms and signature. Metals to be used, donated by the Transvaal Chamber of Mines, came from all the operating gold mines of the Witwatersrand, and from the first platinum ore mined in the Union of South Africa.

Although the cost of the materials is high, the technique involved in reproduction is neither complicated nor expensive. The innovation is finding a much wider application than was first thought possible, and many opportunities are being disclosed to meet the demand for the unusual and the distinctive, apart from the main feature of the process—to preserve for posterity important records and pictorial reproductions in type, halftone, or line cut. Further research in other directions will undoubtedly disclose additional industrial uses for the precious metals.

Silicosis Assumes Steadily Increasing Importance

SILICOSIS, along with six other general forms of occupational diseases, will be included in the extension of the schedule of compensable diseases that has been placed on the agenda of the eighteenth session of the International Labor Conference, to be held in Geneva next year. The United States is not, of course, included among the twenty-two countries that have ratified the Conference's existing schedule of such diseases, which comprises lead poisoning, mercury poisoning, and anthrax infection, and will not be directly affected by any action that may be taken at the forthcoming meeting. Indirectly, however, adoption of the extended schedule by the Conference will undoubtedly have an important influence in this country, giving additional impetus to the movement directed toward combating silicosis, which is well under way here.

Further evidence, for instance, of the increased attention that dust hazards are receiving in the United States is manifest in the issuance recently of a pamphlet entitled "Silicosis" by the Industrial Health Section of the Metropolitan Life Insurance Company. This pamphlet, prepared particularly for the industrialist, presents a brief description of the disease, its causes and complications, and a detailed discussion of preventive measures that may be employed. Widespread reading of the pamphlet is to be desired, for the opportunity of improving dust conditions in various industries is great. Moreover, as the pamphlet points out, the prospect of the silicotic recovering is not favorable. Even when he is removed from dust exposure, the disease often tends to progress and to be complicated with tuberculosis. If, however, he is taken out of dusty working conditions before serious damage to the lungs has occurred, he has a fair chance of maintaining his working capacity. This concise picture of the insidious feature of silicosis should arouse interest in the preventive measures that immediately follow it in the text. Chiefly in this direction would the effective value of the pamphlet seem to rest.

Engineering and Mining Journal, in several early issues, will endeavor to further the general campaign against the disease by presenting a factual record of some of the phases of the silicosis problem as they exist in the mining industry. Not all recent developments in the situation are reassuring, and a better understanding of many of them would seem desirable.

Without Benefit Of Modernization

REPORTS from field correspondents indicate that some gold producers, particularly some of the smaller and newer ones, are not operating as efficiently as modern practice permits. The implication is clear that in failing to purchase modern equipment they are nevertheless paying the price thereof without receiving the benefits that would accrue from its use. Anxiety about the price of gold and desire to take advantage of the prevailing bonus probably obscure the full opportunity for the future as well as the present.

Fully aware of the uncertainty attending the present gold market, we support the warnings that have been sounded against unwise plans for gold mining that may never mature in time to reap the present reward. Nevertheless, we think it timely to point out the opportunities that the present situation affords. The mining of lower-grade ore is obviously indicated, with the economic level determined by careful estimate of the cost and value of the product. But even this advantage does not excuse failure to bring production to the highest pitch of efficiency. Obsolete equipment and processes may seem expedient, but they take their toll of waste that would not only be avoidable under modern technology, but that would pay for the cost of modernization. Once having paid for their original cost, even though it is higher than that of obsolete makeshifts, modern mining and metallurgical machines afford the best insurance for profitable future operation when costs and the price of gold are stabilized. Under these latter conditions high-cost producers will fall by the wayside. The small gold producer should ask himself whether he is merely taking advantage of an extraordinary situation, or whether he hopes and expects to remain in business when economic order is restored. In the latter event he will wisely modernize his mining and metallurgical plant.

Enhancing the Status Of the Engineer

PUBLIC RECOGNITION of engineers as a professional group has been brought measurably nearer to accomplishment through the creation of a new agency that coordinates the activities of a number of bodies hitherto working independently in the interests of the profession. The Engineers Council for Professional Development—ECPD in these days of alphabetical brevity—is the outgrowth of a number of schemes having as their objective the enhancement and fuller recognition of the professional status of the engineer. Modestly recognizing their own important rôle in human affairs, progressive thinkers in the profession, old and young, have been trying to formulate a program to improve their own professional development and recognize their obligations to the public. The ECPD, therefore, is not without its organized forebears. Indeed, it stems directly from the professional societies, from agencies concerned with engineering education, and from those dealing with the relations of engineers to the public as expressed in registration and licensing. Each of these ancestral bodies has promoted its separate activity for the welfare of the engineer. Salients have thus been pushed out along the front of professional development, resulting in an irregular line of advance and suggesting strongly the advisability of consolidating the gains through coordinated action. At this juncture ECPD has been created as a body responsive to its constituent organizations and with a logical program for future professional development. The detailed steps in its evolution need not be recited. Immediate interest centers in its organization, its program, its design for engineers.

The Council's creators and sponsors are the Four Founder Societies of mining, mechanical, electrical, and civil engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners. Without disparaging the importance of other engineering societies, the Council thus organized represents the most influential movement that the engineering profession has ever inaugurated. It is governed by the appointed representatives of the constituent bodies, who elect their chairman, secretary, and executive committee. The Council will function through four committees: on student selection and guidance, on engineering schools, on professional training, and on professional recognition.

The chronological order indicated in the committees' functions is not accidental, but part of the design. It suggests the broad scope, the logical inclusiveness of the Council's activities. Facetiously the program has been referred to as guiding the destiny of the engineer from the cradle to the grave. The first committee will develop information for prospective students that will acquaint them with the opportunities and obligations of engineers, and guide them into or away from the profession according to their aptitudes and capacities. The second will formulate criteria for engineering colleges, ultimately accrediting those institutions qualified to give their graduates a sound educational foundation for the practice of engineering. The third committee will concern itself with the personal and professional development of young engineering graduates during the difficult years following formal training. And the fourth will attempt to define a series of qualifications, standards of achievement, that will merit professional recognition of the mature engineer through membership in professional societies, in granting engineering college degrees, and in license to practice under State laws.

Such is the future design for engineers as conceived by ECPD. It visualizes selection of suitable material, its supervised education, intimate contact with the profession during apprenticeship, and the final attainment of specified requirements, all leading to concurrent recognition by professional societies, educational institutions, and legal bodies. The program is an ambitious one, but its sponsors may be relied upon to proceed with wisdom and caution. In future issues of *Engineering and Mining Journal* we shall discuss the committees' projects in greater detail. In the meantime, we commend the program as the best coordinated effort thus far undertaken to gain for engineers in the future an identity that will be recognized not only by the profession itself but also by the public.

Advance in Dredge Design

New Unit Has Record Capacity for Depth —Deeper Gravels Workable

DEEP DREDGING *requires special equipment of massive construction and large size. This article describes a remarkable achievement in dredge design to meet abnormal conditions encountered by an English company operating a tin deposit in the Federated Malay States. The first recovery units of this kind in the world are now in successful operation there, removing alluvial from great depths. The magnitude of the problems solved by the engineers responsible may be gaged from the fact that the dredge under discussion displaces about 4,000 tons, digs to a depth of over 130 ft., and has a power plant capable of developing 1,400 hp.*

F. G. Payne

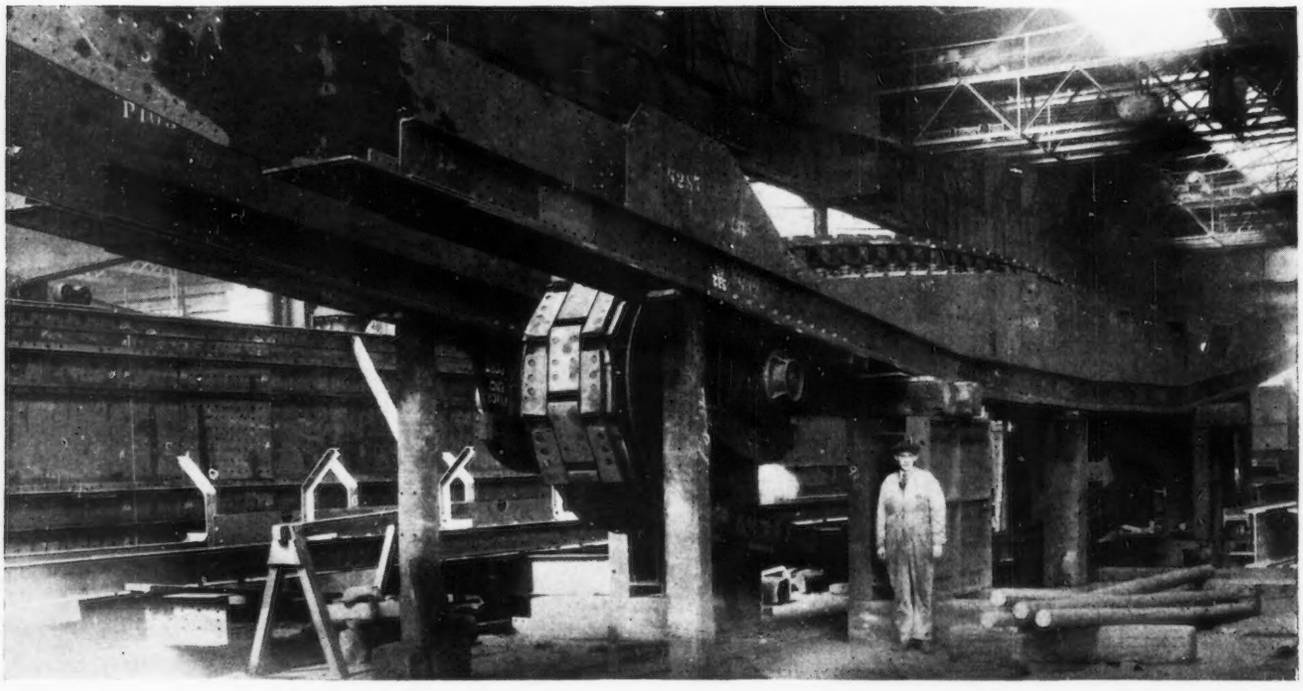
F. W. Payne & Son,
Consulting Engineers,
Dredge Specialists,
London, England

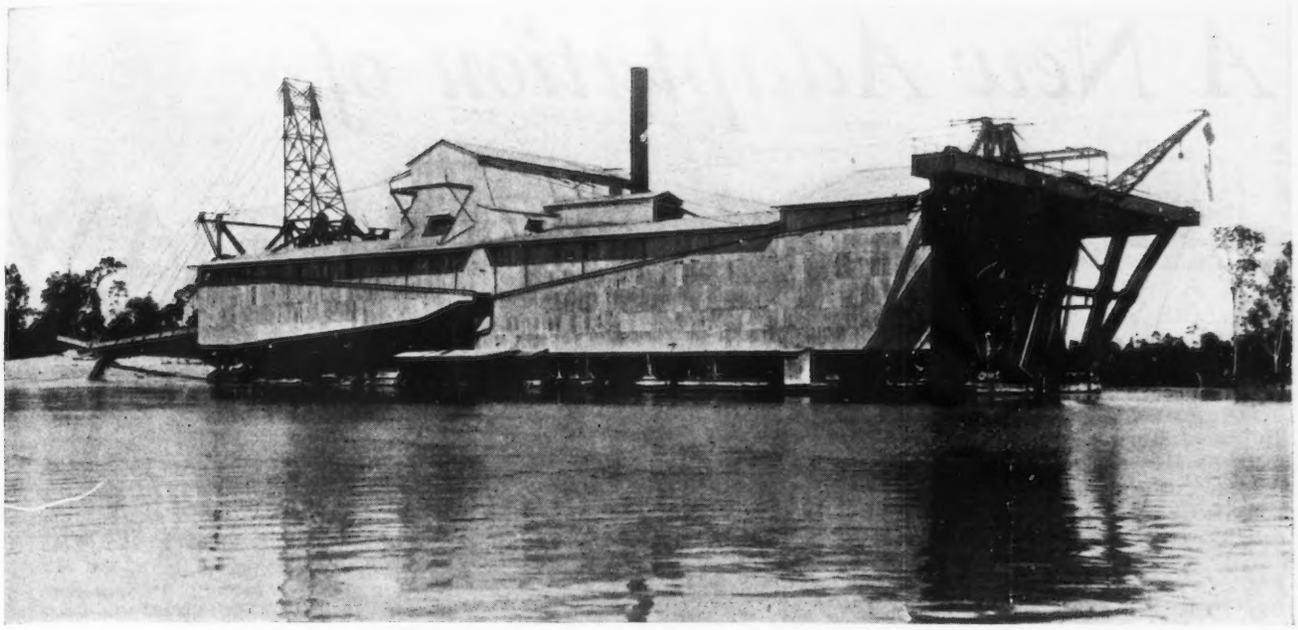
EXHAUSTION of placer deposits at a moderate depth, suitable for exploitation by means of equipment of standard size, has deflected attention to the alluvials known to exist so far below water level that development has been hitherto considered economically impracticable. The problem of recovering tin from depths of 120 to 135 ft., at the property of Killinghall Tin, Ltd., in the Federated Malay States, necessitated many radical departures from customary dredge design. It resulted in the construction and operation of a vessel with a displacement of nearly 4,000 tons, qualifying as the deepest digging-bucket dredge in the world, possessing many new and patented features. Dredging has been successfully carried on to a depth of 132 ft. below the water line.

To control the long bucket chain, and to cause the buckets to enter the working face at the correct angle, without dragging excessively on the bottom, a special form of caterpillar track was invented to support the buckets on the underside of the ladder. An idler tumbler at each end is provided, over which an endless chain of trays, shaped to accommodate the lips of the buckets, moves with the bucket chain, this movement being given to the trays by the buckets. A picture of the track under construction is shown herewith. This track is accommodated in the comparatively small open space shown at the top of the view of the inverted ladder in another cut, which illustrates the immensity of the ladder.

Considerable pressure takes place under working conditions between the ladder and the well side of the pontoon when the dredge is pulled across the face by the side lines. In a deep-dig-

Construction photograph showing special caterpillar track to support buckets





Dredge of Killinghall Tin, Ltd., Federated Malay States, in operation

ging machine, such as the one under description, this difficulty is greatly accentuated by the extensive bending moment resulting from the comparatively short distance between ladder-pontoon point of contact and pivot shaft, as compared to the distance from the bottom tumbler to ladder-pontoon contact point. To obviate this, the stresses were triangulated by extending the bow gantry of the dredge in a lateral direction on each side, and by bringing the ladder line to an anchorage at each extreme end of this structure. Thus, when the dredge is moved laterally by the sidelines, the tension in the diagonal rope from the extended gantry to ladder-bottom end helps to pull the buckets across the face. This reduces the lateral stresses in the ladder and, incidentally, relieves the pressure on the pontoon chafer bars.

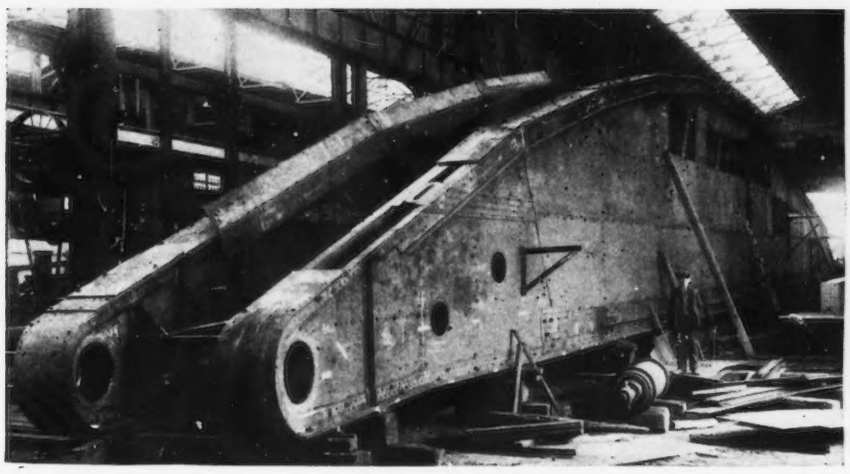
Because of extensive pontoon length, in a unit of this size, the problem of tailing disposal is serious only before the dredge has developed a normal paddock—at the commencement of opening-out operations. In the Killinghall dredge this difficulty has been overcome by elevating the tailing at the stern end with a gravel pump, and discharging through a pipeline about 200 ft. behind the stern. The ground to be handled by the dredge carries about 60 ft. of barren overburden, which is bypassed through a chute at the side of the screen and discharged over a long tail chute. This material is thus discarded without sending it through the tin-saving plant. The picture at the top of this page shows the dredge in operation. It has moved astern after stripping overburden, and is now digging deeply.

The pontoon, 276 ft. long by 65 ft. wide and 11 ft. 6 in. deep, is of steel construction throughout; frames are 2 ft. apart; ample stiffening is provided under the machinery beds. The ladder is of the bow-girder type, with special provision for washing down the tray and facilitating the sluicing out of material at the bottom end that might cause blockage by slipping in from the working face. The ladder is 195 ft. long from center of bottom tumbler to center of pivot shaft. Buckets, of the close-connected type, each with a capacity of 12 cu.ft., are of cast manganese steel, with lips and bushes of the same material; pins, 7 in. diameter, are made of nickel-chrome-molybdenum steel. Pin heads are fitted with a locking device to prevent a movement that would result in unnecessary wear. Gears have machine-cut teeth, insuring smooth and efficient running; and special steels have been used throughout.

Motive power is steam, and special effort was made to provide a plant that would operate economically. The boiler, a Babcock & Wilcox, is equipped with chain-grate stokers, economizer, and superheater. Fuel used is coal, mined locally, with a calorific value of about 8,600 B.t.u. per pound. Engines are of the triple-expansion type, with expansion governing. The dredging engine is fitted with reversing gear and with equipment to vary the speed between 220 and 185 r.p.m. without stopping the engine. Total power developed by the various engines is about 1,400 hp. Equipment includes a water-softening plant.

The tin-saving plant comprises twenty primary and two clean-up jigs, each motor-driven and therefore capable of individual regulation. A 95-kw. generator set is used for supplying direct-current at 250 volts to the jig motors. Concentrate from the primary jigs flows by gravity through a system of chutes and dewatering boxes to the clean-up jigs. Product from the low-grade hutches of the clean-up jigs is then returned to a sump and pumped up for further treatment. The concentrate is conveyed ashore for final dressing in the tin shed.

Construction photograph of inverted dredge ladder. Note open space at the top, where the special caterpillar track is accommodated



A New Adaptation of the WIRE SAW

Makes Large Horizontal Cut Successfully

WIRE SAWS are finding wider use in cutting dimension stone, notably slate and limestone. Introduced in Pennsylvania slate quarries a few years ago by the United States Bureau of Mines, they are now regarded as essential to the industry, for by their use raw materials have been conserved and quarry costs greatly reduced. Full details are now available in a published report.[1]

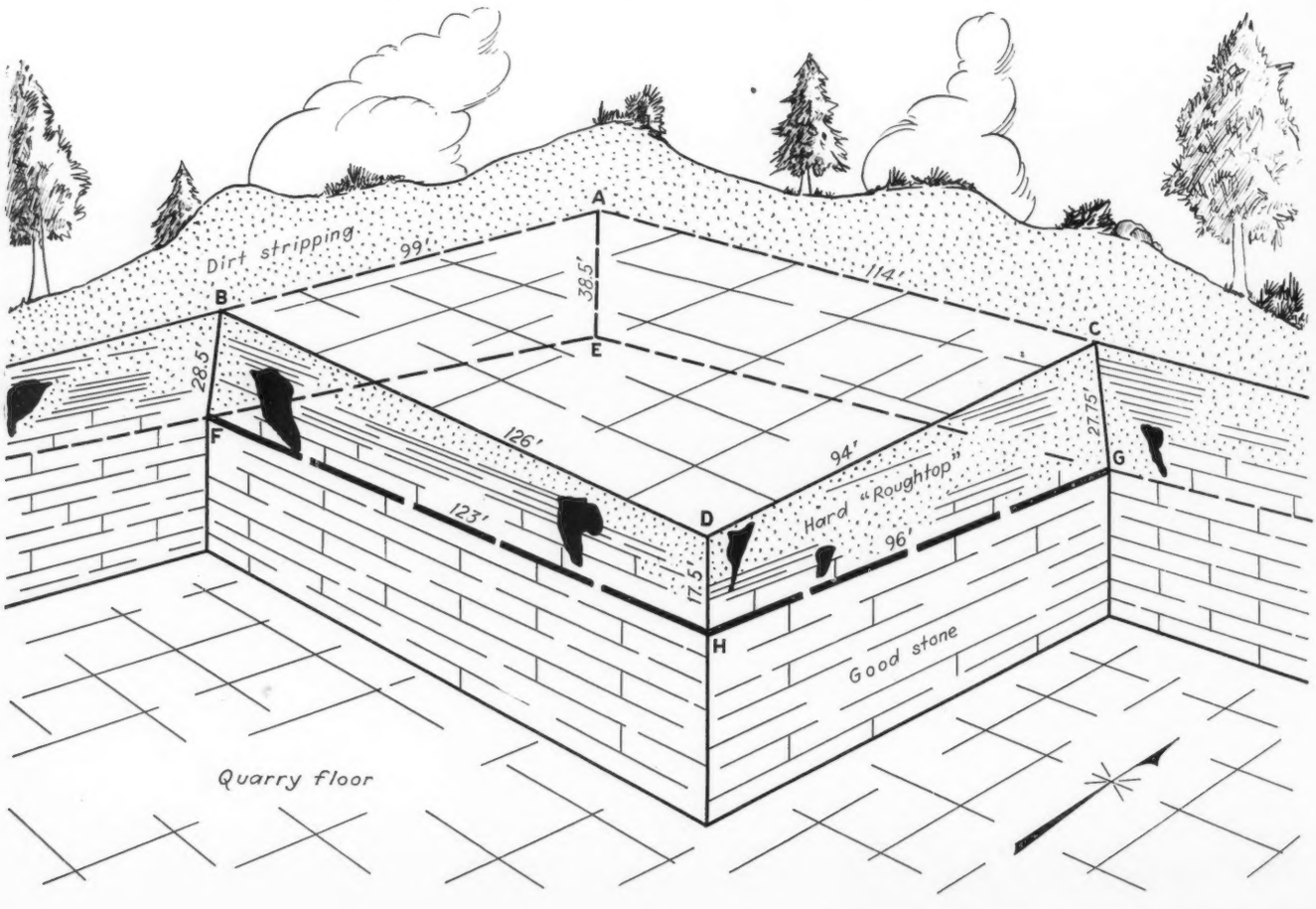
A few years ago the senior author of this paper visited European quarries where wire saws are used much more extensively than in America, and their extreme flexibility under diverse conditions convinced him that properly operated and with the work systematized to fit the high-production quarries of Indiana they could be used with equal satisfaction in that field. The success of experimental work conducted in an Indiana limestone quarry in 1931 under his supervision fully justified this conclusion.

Making vertical and inclined wire-saw cuts in solid rock is now regarded as comparatively simple and eminently satisfactory, but the most recent accomplishment is utilization of a wire for making a large horizontal cut. To test its adaptability for such use, a definite problem was recently presented in the Indiana limestone district in the neighborhood of Bloomington and Bedford. This region is the chief building-limestone center of the United States, providing about 87 per cent of all material of this kind quarried in the entire country.

The Salem limestone of Indiana occurs in a massive bed varying from 25 to nearly 100 ft. thick, dipping gently to the west. Much of the stone now quarried is overlaid with 20 to 60 ft. of

[1]Bowles, Oliver: "The Wire Saw in Slate Quarrying." United States Bureau of Mines Technical Paper 469.

Fig. 1—Diagram showing the block undercut at Maple Hill quarry



J. B. Newsom and Oliver Bowles

limestone of inferior quality, and this rock must be removed as waste before the high-grade rock can be quarried. The simplest way to remove it is by blasting, and the blasting method is followed if it can be done without damage to the good stone. Use of explosives is carefully avoided in quarrying building stone, for even small charges will shatter and destroy it. Overlying rock cannot be removed by blasting, therefore, unless an open seam is present between the poor rock and the good ledge below. If such a seam is present, the shattering effect of moderate blasts will not penetrate beyond it, but if no seam is there, cracks will continue into the good stone below and destroy it. Where no seam is present, the top ledge must be channeled and removed laboriously as quarry blocks—blocks that are valueless and yet having the same costly labor expended on them as is required for high-grade mill blocks.

In the Maple Hill quarry, near Bloomington, a limestone ledge open on two sides is covered with inferior stone in a bed about 30 ft. thick. Quarry conditions are shown in Fig. 1. The top stone is hard and therefore expensive to channel. As there was no open seam between it and the good stone, however, blasting was apparently out of the question and channeling seemed the only feasible way of removing it. When the question of removing this hard top stone came up for serious discussion, the idea was advanced that if it could be entirely freed from the ledge by wire sawing, it could then be blasted without fear of the powder cracks running into the good stone. The senior author signed a contract to do this sawing in two steps:

First the two end cuts *ABEF* and *ACEG* (Fig. 1) were to be put in with wire saws not only to the full depth of the overburden but sufficiently beyond it that the center of the cut which lags behind would reach well into the good stone.

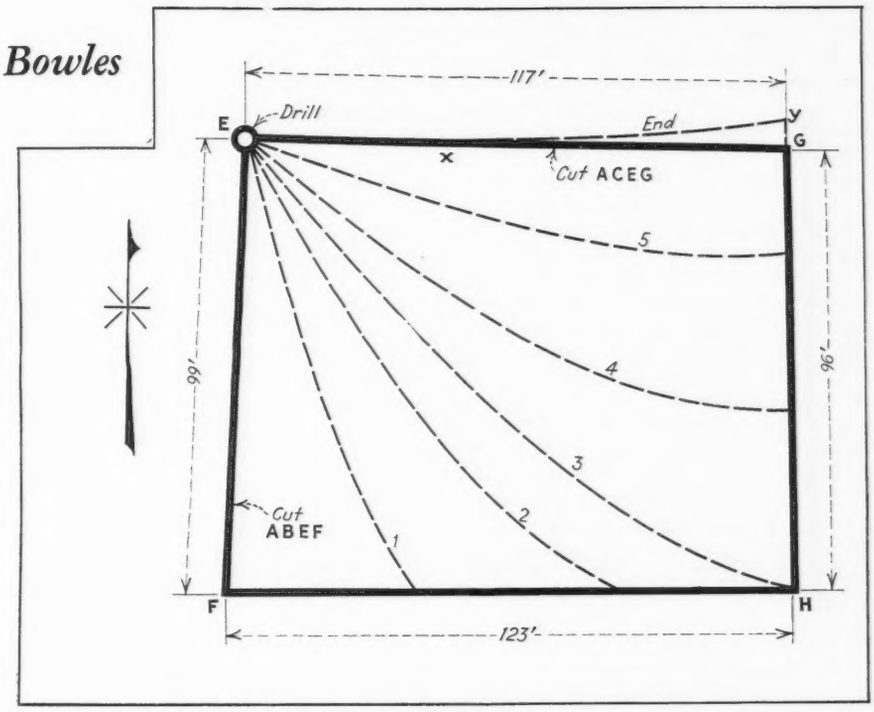


Fig. 3—Plan of the horizontal cut, showing the sequence of sawing steps. The dashed lines represent the position of the wire at the end of each step

Second, the bottom cut *EFGH* was to be put in.

In wire sawing it is necessary to get at both ends of the cuts to be made. For this reason, an opening had to be made at *A* (Fig. 1) which would extend the full depth of the overburden. For the reason that blasting was out of the question and because the opening at *A* should preferably be large enough so the sawyers could go down into it, a core-drill hole at least 3 ft. in diameter

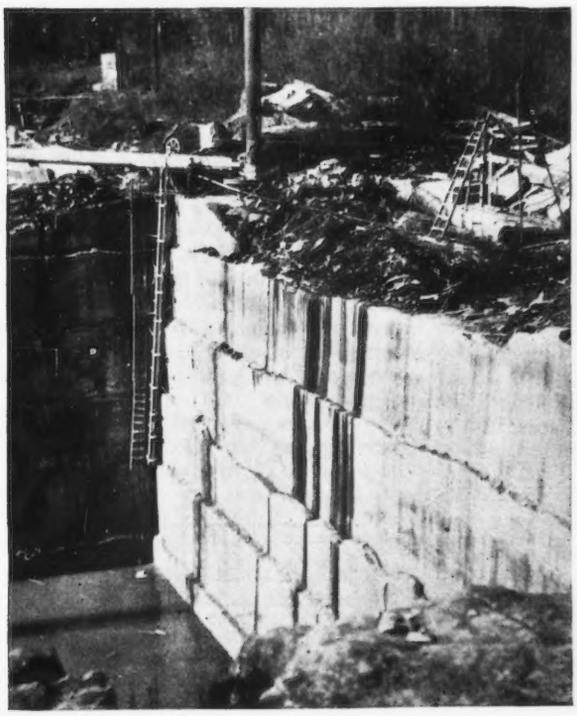
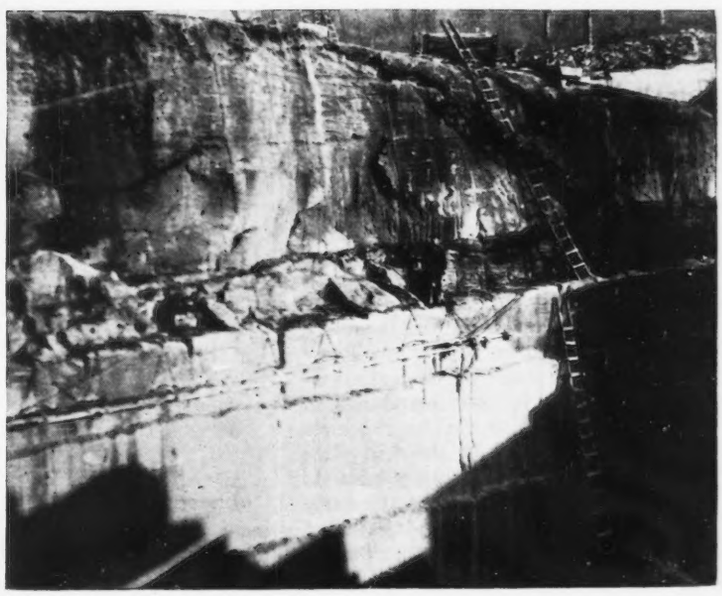


Fig. 2—The northeast end standard at Maple Hill quarry, rigged for the north cut

Fig. 4—View of the guide standard in its second position during undercutting



was required. This was not an original idea, because core drills have been used for wire sawing in Europe and America for some years. In fact, the development of a practical drill for the end openings which would meet American operating conditions was one of the main questions that had to be solved when wire saws were introduced in the Pennsylvania slate district by the Bureau of Mines.

Inquiries revealed that such drills are expensive, so a sketch of a drill believed suitable was made and sent out for bids. The bids were far above the contractor's estimate of the probable cost. To simplify the machine and also to display its construction and operation, a cardboard model was fashioned, and by making repeated changes a design was finally obtained consisting of a minimum number of pieces, nearly every one of which could be made of standard plates or structural shapes. This model so improved matters that the price paid for the drill was closely in line with the contractor's original estimate and was about $400 below the first bids.

The drill was received Oct. 6, about two weeks after the order had been placed, and was put in operation at once. It turned too rapidly at first, so the speed was reduced, and drilling started in earnest on Oct. 8. The hole was drilled with little trouble, except that two cavities encountered caused the shot to run out from under the drill bit, and so delayed the cutting.

New Drill Satisfactory

The drill hole showed that the overburden was 38.5 ft. deep at the point *A* (Fig. 1). It was drilled to a total depth of 48.7 ft., however, to provide a sump for the débris which would subsequently accumulate. The operation took ten days of steady drilling, 24 hr. a day during most of the time. The cores were pulled out by hand because it seemed that the labor saved on the single hole required by this first job would not justify the extra cost of a power hoist for pulling cores. A curve made by plotting the time of operation against the depth of hole drilled shows that the drilling speed did not materially change as the depth increased. The efficiency of the operators must have increased fast enough to balance the time lost in handling longer drill rods, pulling the core farther up, and similar operations.

As soon as the drilling was finished, the end standards were rigged to make the two end cuts *ABEF* and *ACEG* (Fig. 1). A view of the end standard *CG* in place is shown in Fig. 2. These standards were made by fastening together several wire-saw standards of ordinary length. The various deadeyes and hooks used to fasten them in place were put into the ledge with sulphur to assure absolute security. As the crew was not skilled at working against a vertical rock face, the operation proved slow and expensive.

When this rigging was finished, the cuts *ABEF* and *ACEG* were put down. The equipment was so arranged that the two were made simultaneously with a single wire. Due partly to the hardness of the stone, but mainly to the fact that the crew did not know just how to go about the work, cutting advanced very slowly. On two occasions wires broke in the cut, and sawing down again from the top was necessary. Once a wire stuck in a cut, and nearly a week was consumed in getting it free. During this part of the work it was forcibly impressed on the contractor that successful wire sawing of long, deep cuts requires knowledge and experience.

A Wire Breaks

To make sure that the cuts *ABEF* and *ACEG* were finished, the end sheaves were all turned down 7 ft. below the top of the good stone, and the saw was kept running till most of the center lag had been taken out. Then the wires were raised back to the top of the good stone preparatory to undercutting. During this operation, unfortunately, the wire in cut *ACEG* broke. This meant that there was a wire through the bottom of cut *ABEF*, and that cut *ACEG* was completed but had no wire through it.

Rather than take the time to get a new wire in the north cut, the contractor decided to start undercutting with a single wire. The idler sheave in the drill hole was rigged so it would swing as the wire turned, the end standard on the southwest corner was laid on its side, and undercutting was started by pulling the guide sheave eastward along the line between the "rough-top" and the good stone. Either because the crew had learned more about manipulating the saw or because the stone was softer, this operation went smoothly. When the cut reached the end of the standard, the latter was moved its length along the face, and sawing was continued. In this way the end standard was moved around the ledge in six stages (see Figs. 3 and 4).

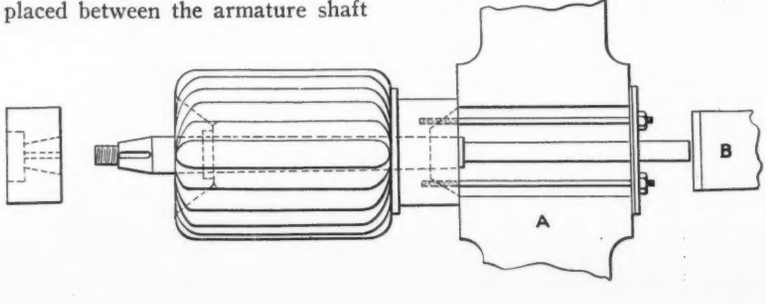
The contract called for a complete separation of the top rock from the ledge, which meant that the bow at the point *X* (Fig. 3) must be sawed out. Fortunately, the wire could be advanced about 3½ ft. past the end of the north edge at the point *Y* (Fig. 3). This was done, and after sawing for several hours the wire was running almost in a straight line. Those in charge expected that the ledge might crush down on the wire and break it during this last operation. When the work was nearly finished the wire suddenly jerked, and then slacked off, but it did not stick. This may have meant that the ledge had broken down but had not caught the wire, or that the wire had simply pulled through into the old north cut. The work was finally finished, and the saw stopped on Jan. 9, 1933, 93 days after the drilling was started.

The block thus severed from the ledge contains 318,475 cu.ft. of stone and weighs about 24,000 tons. It is probably the largest block that has ever been separated by sawing in America.

Electric Locomotive Repair

A FREQUENT MAINTENANCE JOB confronting the mine electrician is rewinding of motor armatures. At the electrical department of the Miami Copper Company, Miami, Ariz., writes A. T. Tizard, when servicing the armatures of the 10-ton electric locomotives, this is accomplished in the following manner: The drive pinion is removed with a standard gear puller, and the commutator by the simple set-up shown in the accompanying sketch. The armature is bolted to the back of the hydraulic press tailpiece *A* by two 1-in. tension rods screwed into the two holes of the commutator hub which previously had been enlarged and tapped to 1-in. A piece of shafting of suitable length is then placed between the armature shaft and the press ram *B*. Additional pressure exerted by the press ram will gradually detach the commutator from the shaft.

To insure a perfect mesh and prevent the drive pinion from becoming loose, a tight fit between the pinion bore and the armature shaft is essential. When the pinion is lapped to the shaft this is obtained as follows: First the correctness of the taper is determined by a small amount of lapping. If found true, the operation is continued until a 75 per cent contact is attained. Next, the pinion is heated to about 200 deg. F., then mounted on the shaft, and pressed upon the taper by the lock nut on the end of the shaft.



Analysis With Wedge Spectra

Its Recent Application to Zinc On a Quantitative Basis

Morris Slavin

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APPLICATION of the spectrograph to quantitative analysis is more than 45 years old—and is still a laboratory curiosity. The reason is not far to seek. Aside from the senseless fear of chemists of anything pertaining to optics or photography, the older methods of spectrum analysis were admittedly difficult and required much preliminary work. University laboratories found this preliminary work not justified for their few samples, and industrial laboratories found the orthodox methods more convenient and rapid for routine work. Recent advances in the science, however, have considerably simplified both preparation and procedure.

The method in most common use at present is that of A. de Gramont[1]. It consists in comparing a photographic spectrogram of the unknown sample, taken under standard conditions, with one of a series of prepared standards, previously taken under the same standard conditions, and determining the agreement in intensity of the spectral lines simply by inspection. This procedure cannot be duplicated in other laboratories without repeating the standardization, and the precision is low and is entirely dependent on the care with which the exposures are made. Certain of these objections were eliminated by the modification in use by C. C. Nitchie, who photographed the spectra of the standards in juxtaposition to the unknown's spectrum for each determination. This arrangement overcomes variations in exposure and development, but adds factors which considerably complicate the determination. Furthermore, a set of standards must always be on hand, and without these standards the procedure is no more reproducible than with the original de Gramont method.

Recently a great advance has been made in the whole subject by the work of Prof. W. Gerlach and his pupil E. Schweitzer. Gerlach purposes to equate the intensity of the spectral lines of the unknown element with lines of the base substance, on the same photographic plate, for various percentage compositions. Schweitzer pointed out that, for sake of accuracy, line pairs which are "invarient" must be chosen for comparison, and gives in his paper the test for this invariency. The correlated line pairs, one of the unknown and one of the base substance, are called "homologous lines," and the method is usually referred to as the "internal standard" method of Gerlach.

The advantages of this procedure are obvious. As any change in exposure and development of the spectral image will affect both the line of the unknown element and of the base material to an equal degree, several of the objections to the older methods are eliminated. The procedure is easily reproducible, the standardization results being in the form of tables, only one exposure is required for a determination, and inasmuch as only a narrow band across the plate is exposed, several determinations can be taken on the same plate; and, finally, the precision is higher than is possible with de Gramont's method, while requiring less care in exposure. D. M. Smith has recently described the application of this method to the analysis of zinc.

The internal standard method has one serious fault. Its success evidently depends entirely on finding suitably spaced homologous lines. If either of the two elements involved has a simple spectrum, or one whose lines are not sufficiently graded in intensity, the method falls down. The difficulty was neatly overcome by Scheibe and Neuhausser, who applied a simple photometer to the measurement of the *relative* intensity of the two homologous lines, instead of merely noting their equality. The photometer consisted of a thin rotating metal disk whose edge had been cut away in a logarithmic curve. This logarithmic wedge sector, mounted on a shaft, was placed as close as possible to the slit of the spectrograph and rotated rapidly, giving an intermittent, variable exposure along the length of the slit. The type of spectrum produced by this arrangement is shown in the photographic reproduction here presented. The exposure, being variable, causes a gradual tapering off in intensity of the lines, from a maximum to some point of complete disappearance. Each spectral line has been altered to a "wedge." With this procedure the length of the line (wedge) is evidently a function of its intensity, and as the intensity is a function of the concentration of the element in the sample, the length of the line is a measure of the concentration of the element. As this photometer is the mechanical equivalent of the familiar neutral glass wedge, the spectrum it produces is called a wedge spectrum.

The procedure, with later corrections made by Twyman and Fitch, is somewhat different from Gerlach's. The lengths of the lines of the homologous pair, on a plate exposed under standard conditions, are measured by means of an ocular micrometer. Then the difference in length of a chosen line from the "unknown" compared with that of the "known" element is referred to a graph previously prepared from known standards, and the percentage read off. The line of the main constituent is here used simply as a control to correct for slight differences in exposure, emulsion, and development.

Experimental

The problem which led us to try the spectrograph was the determination of cobalt, iron, copper, cadmium, thallium, germanium, and lead in strong zinc sulphate solutions and of iron, copper, cadmium, and lead in metallic zinc in connection with an experimental electrolytic zinc plant. Our attempts with iron,

[1]For summary of de Gramont's work and that of the earlier investigators, see Twyman, "Wavelength Tables," published by Adam Hilger, Ltd., London, 1923.

copper, and cobalt failed, for reasons to be explained, but for the four other metals we were able to develop methods which proved quite satisfactory. As the object of the plant was the manufacture of zinc of 99.99 per cent purity, the impurities present in both types of sample were always extremely small.

In attempting to follow the procedure of Twyman and Fitch we saw at once that the spark, on grounds both of low sensitivity and inconvenience of manipulation, was not suitable for our type of sample. The previous investigators had used the wedge sector for ferrous alloys, and the constituents they had sought to determine were present in rather high concentration. The arc, and more specifically the carbon arc, was evidently much more appropriate to the purpose, and certain advantages appeared to lie in reducing both metals and solutions to salts, in our case to sulphate.

The chief advantage of working with salts is the ease with which standards can be made up. In using zinc sulphate as the base substance, in making up a series of mixtures covering the working range, one needed only to add definite amounts in the form of solutions of the determinable metals to a definite quantity of zinc sulphate, and then to evaporate this mixture to the dry salt. Another possible advantage in the use of salts, which may prove of even greater importance, will be discussed later in this paper.

Apparatus and Arrangement

The spectrograph used was the high-dispersion, quartz instrument (E 383) of Adam Hilger (London), taking the entire spectrum on four 4x10-in. plates. As the change-over from one spectral range to another, though simple, would be inconvenient in routine work, a range was chosen which included *raies ultimes* (arc) of all the metals usually associated with zinc. This range was from 4220 to 2710 I.A. (International Angstrom units.)

An instrument of such large dispersion may appear unnecessarily elaborate in dealing with a metal having so simple a spectrum as zinc. But this great dispersion proved quite worth while in the present work, in a way not previously stressed, even by the manufacturers. The advantage of a more open spectrum consists in that, with so few lines available for analytical use in a simple spectrum, none should be masked by other lines.

The arc was placed 42 cm. from the slit. The condenser, a quartz double-convex lens of about 15-cm. focus, focuses the image of the arc on the prism instead of on the slit, as is customary. This can be done easily by opening the slit aperture wide and observing the image of the arc through the plate-holder aperture. The eye must be placed in the region of visible light; if this is impossible for any prism setting, the prism must be turned until the image can be seen. If the light from the incandescent poles is allowed to reach the photographic plate, fogging will result. The arc is therefore operated so that only the middle half of the gap is used. This adjustment can be made readily by observing the image through the plate-holder aperture. The position of the arc and the separation of the poles can be checked during exposure by means of an image thrown on a neighboring wall by a suitably placed lens.

An important consideration is that the photometer disk be placed as close to the slit as possible. This instrument, also made by Hilger, consisted of a crank-wound spring motor which rotated the disk through a spiral gear. The constant winding proving too troublesome for routine work, the spring motor was soon replaced by a small electric motor controlled by a ball governor to give a disk speed of 300 r.p.m.

The arc circuit consisted of a resistance of 50 ohms in series with the arc holder. This was connected to a 250-volt d.c. line. The current, therefore, with the gap closed was 5 amp.

Identifying Spectral Lines

The means employed of locating and identifying spectral lines was somewhat different from the ordinary and may be worth describing. Hilger's firm supplies enlarged photographic prints of a spectrum containing the principal lines of a great many of the elements, the lines being marked as to wave length and element. The original spectrograms had been made with an instrument of the same design as ours, so that we found it possible, after determining the degree of enlargement in the photographs as compared to our spectrograms, simply by scaling off with a millimeter rule from a known line as a reference, to determine the identity of unknown lines. This obviated the use of an expensive and cumbersome micrometer microscope, and saved money in time. This procedure was used only at the beginning, as with practice identification of lines by inspection from their position in the spectrum became easy.

Electrodes

Several important considerations point to the choice of carbon as electrode material. It is cheap, easily cored and washed after use, burns steadily at a comparatively low voltage, and the high temperature at the poles results in an extremely sensitive spectrum. Two serious disadvantages of carbon are (1) the so-called CN bands and continuous background mask a valuable portion of the spectrum; and (2) pure carbon electrodes cannot be obtained.

Acheson graphite rods, irreproachable from the standpoint of purity, were tried at first, but were rejected because the arc tended to extinguish easily and because the spectrum was less sensitive, due to the higher heat conductivity of graphite. Carbon was accordingly chosen, and used for the standardizations and all the subsequent analyses. The standardization curves and results presented were obtained with 7-mm. carbon electrodes.

Later, in an effort to overcome troubles due to impurities in the carbon electrodes, experiments were again undertaken with graphite, with gratifying success. The electrodes used were $\frac{1}{4}$-in. round rods. The difficulty that resulted because of heat loss was reduced to a minimum by making the lower electrode, carrying the sample in its core, very short, about $\frac{1}{2}$ to $\frac{3}{4}$ in., and imbedding this in a carbon bushing, thus insulating it thermally without interfering with the electrical conductivity. The annoyance caused by the blowing out of the arc was nearly overcome by increasing the current in the circuit to 10 amp. These changes produced a satisfactorily steady arc of great spectral sensitivity.

The pulverized sample is stuffed into the core of the short, lower electrode. The upper electrode is a long graphite rod which is not changed between exposures, experience having shown that contamination does not take place. As this electrode remains fixed in the holder, it serves to locate the position of the electrode carrying the sample. As is customary, the lower pole is connected to the positive side of the line. After each exposure the sample electrode is discarded.

Preparation of Samples

Working with salts has the advantage that both metals and solutions can be reduced to the same form and treated alike. The nature of the acid portion of the salt has an important influence on the characteristics of the arc and therefore on the resulting spectrum. As is well known, the current passes across the arc gap by means of the gas formed from the vaporization of the electrode material by the high temperature, the temperature developed being only that necessary to cause this vaporization. If the material in the core vaporizes easily, the temperature is low. For this reason chlorides in general give a low-temperature arc. In consequence, this type of arc is not sensitive and its spectrum contains little besides the resonance lines. Nitrates are unstable in the arc. Sulphates, on the other hand, have not these disadvantages. They usually give a high-temperature arc, and, in addition, can easily be prepared in stable form by evaporating a sulphuric acid solution to dryness, which drives out chlorides and nitrates. Furthermore, sulphates do not readily absorb atmospheric moisture and can therefore be handled conveniently in powdered form. For these reasons the sulphate was used in our work.

The sample, then, of the metal, is dissolved in concentrated nitric acid, sulphuric acid is added, and the solution

evaporated to dryness. With zinc sulphate solutions, a small portion is evaporated slowly to dryness to avoid spitting. The dry cake is then powdered in a small agate mortar. Only about 50 mg. of the powdered salt is necessary for an exposure; but for ease of handling about half a gram is taken.

The results in the handling of solutions are reported in terms of milligrams per 100 grams of zinc, as the method of preparing the sample makes the volume, the customary unit, meaningless. Results can readily be converted to milligrams per liter, as the zinc contents of our solutions are always known.

Photographic Procedure

Conditions governing the choice of a plate for the photography of wedge spectra are maximum contrast and resolution. These qualities are possessed by the "process" type, but it proved too slow to give the required sensitivity with the exposure time we were willing to allow for routine work. The Eastman 33 plate, having somewhat more speed and less resolution, was chosen as a compromise and has proved satisfactory.

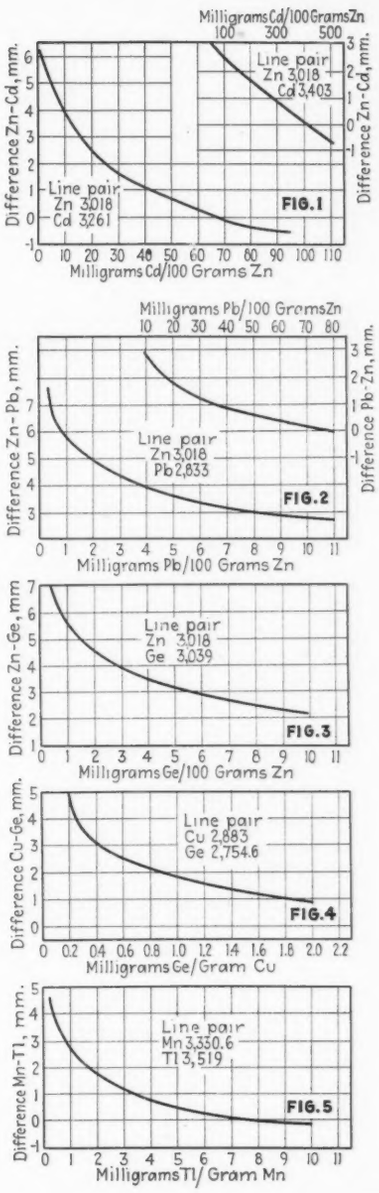
To give an image presenting as great a degree of contrast as possible, the plate is developed in Eastman's D-11 developer. This, although it does not give quite the contrast of one containing caustic soda, keeps well and is more convenient. It is used full strength, in a home-made tank, developing for 4 min. at 18 deg. C. Fixing is done in standard acid hypo.

Standard Curves

The starting point in preparing the standard curves is the preparation of pure zinc sulphate, the base material, "pure" in this case meaning the absence of the hydrogen and ammonium sulphide group metals. Starting with a concentrated neutral solution of zinc sulphate made from the C. P. salt, the hydrogen sulphide metals are removed by treatment with zinc dust at boiling temperature. To the filtrate a small amount of manganese sulphate is added, and the manganese precipitated with potassium permanganate — the well-known Volhard reaction. The bulky precipitate completely removes the smallest traces of the alkaline sulphide metals likely to be present. Any excess permanganate can be removed by allowing the filtrate to stand for a day or two days, when the permanganate decomposes into manganese dioxide, which is filtered off.

From this solution the standard mixtures are made by adding known amounts of the metals to be determined, in the form of standard solutions, to a definite quantity of zinc sulphate. These mixtures are evaporated to dryness, powdered, and their spectra photographed under standard conditions.

The choice of a control line of the base material is made on the basis of its proximity to the center of the plate, and its length, which should be about three-fourths of the fullest length possible. Choosing a suitable line of the unknown to complete the homologous pair is usually more difficult. A list should be made of all lines in the working wavelength range that are likely to appear at the concentrations used. This can be done from an atlas of spectral lines; the International Critical Tables, Vol. V, contains such an atlas. Then by inspection of the standard plates the useless lines can be eliminated, leaving the choice to one line or to a very few lines. The unknown line should be as close to the control line as possible, and, to avoid masking, should be easily resolved from the principal lines of all impurities likely to be present.



Standardization curves for the determination of cadmium, lead, thallium, and germanium

With certain line pairs decided on, the next operation is to measure their lengths for each concentration and plot the difference (preferably making the length of the unknown line the subtrahend) against the concentration. Theoretically, using a logarithmic wedge sector plate, the graph should be a straight line when plotted against the log of the concentration, and this indeed is so with our results, except that for some obscure reason there is a deviation at both ends of the range. The curves published by Twyman and Fitch, at least those obtained with the spark, could not be reduced to so simple a function. This is an additional advantage in favor of the arc, for the possible errors of the determination are more evenly distributed over the working range, and fewer points are required to fix the curve.

Measurement of the lengths of the tapering lines is difficult to do with accuracy. The maximum error is about 0.2 mm., and even this is attained only after some practice. The same person who determined the calibration curve should do the routine work, to reduce personal errors. The sharpness of the end point can be improved by adjusting the spectrograph to critical focus, by developing the plate to maximum contrast with minimum of fog, and by placing the arc as far from the slit, and the photometer disk as close to it, as circumstances will permit, thus reducing the parallax caused by a light source of appreciable size.

Length of exposure depends on several factors. It should not be too short, even when feasible, as the arc does not burn absolutely steadily, so that a longer exposure tends to reduce this possible source of error. Too long an exposure is inconvenient for routine work, besides causing excessive fogging and accentuating the continuous background. We found 30 sec. to be a good average.

The Metals

Cadmium. In the range 4220 to 2700 I.A. the most persistent of the cadmium lines is 3261. The usable range of this line with our conditions is from about 2 to 90 mg. of cadmium per 100 grams of zinc, although it is still visible at a concentration of less than 1 mg. per 100 grams of zinc. As the lower portion of this range fitted our requirements for the analysis of our purified solutions and zinc cathodes, there was no option but to use this line. Experience proved it suitable for determining cadmium at these low concentrations. The standardization curve is shown in Fig. 1.

Wishing to use the spectrographic method on crude solutions containing up to 500 mg. of cadmium per 100 grams of zinc, we investigated the suitability of some of the weaker cadmium lines in the range for which the spectrograph was set. The line Cd 3403 proved the most

convenient for this purpose. Its standardization curve is also shown in Fig. 1.

The homologue, or control line used with the cadmium lines, and also with all the other analytical lines when zinc was the base material, was Zn 3018.

Lead. This metal is extremely sensitive in the arc. The *raies ultimes,* the lines 4057.8, 3683.5, and 3639.6, are partly masked by the carbon bands; however, the line 2833.1, only slightly less sensitive, is in a region free from strong background and is eminently suitable for measuring. Even though it is one of the weaker lines, by its use one can get down to about 0.4 mg. lead per 100 grams of zinc. See Fig. 2. To extend the range upward, the near-by line 2823.2 can be used.

Germanium. This metal, so difficult to determine in small amounts by chemical methods, yields readily to the spectrograph. One can get down to about the same degree of sensitivity as with lead (see Fig. 3). The line used for the analysis, 3039.1, is extremely close to one of the sensitive lines of indium, 3039.35. The two cannot be separated by spectrographs ordinarily used for chemical analysis, so care should be taken, when using the germanium line 3039.1, that indium is absent from the sample. If the slightly more sensitive indium line 3256.1 is absent from the spectrum, the interfering line will also be absent.

The sensitivity attained, great though it is, was not sufficient for our purpose. To lower the range, recourse was had to a method of chemical collection similar to the method used in colorimetric analysis. To the solution to be analysed for germanium, a measured quantity of copper in the form of the sulphate solution was added. The acidity was adjusted to about 15 per cent with sulphuric acid and hydrogen sulphide gas passed in until the precipitated copper sulphides flocculated. These were filtered off, transferred to a small beaker (not necessarily quantitatively), and nitric and sulphuric acids added. The mixture was evaporated to dryness, and the salt, which was now copper sulphate, treated in the same manner as the zinc sulphate. The comparison used here was the germanium line 2754.6 with the copper line 2882.95. Results are shown in Fig. 4.

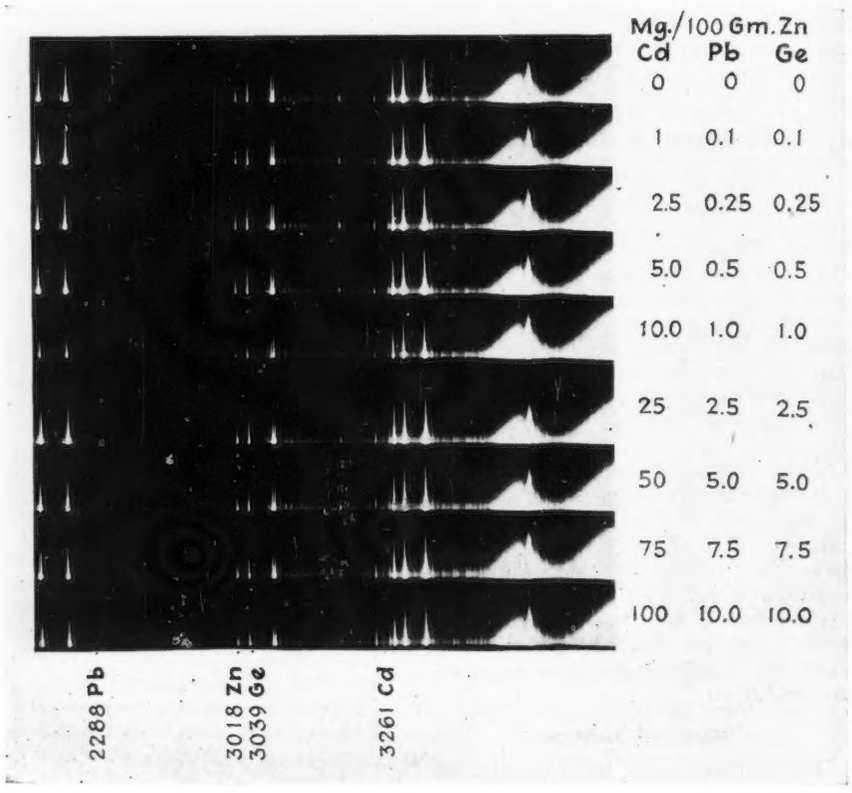
The completeness of the germanium precipitation was checked by a spectrographic examination of the filtrate from the copper precipitation. As here described the procedure simply transfers the metal to be determined from one base material to another, the quantity of the latter being under control within wide limits. The sensitivity attainable by this means is far greater than the curve of Fig. 4 would indicate. One need only reduce the quantity of collector added. By actual experiment, we have found that co-precipitation with as little as 20 mg. of copper will completely remove the germanium from one liter of solution. The limit of sensitivity in this case, using only a liter of sample, is therefore about 0.01 mg. of germanium per liter.

Thallium. Determination of this metal presented a somewhat different problem. The most sensitive thallium lines within the range 4220-2700 are 3775.7 and 3519.2. However, these lines are completely masked by the carbon bands, so that their use in the direct arc spectrum of zinc sulphate is out of the question. The next most sensitive line, 2767.9, appears at a concentration of about 10 mg. of thallium per 100 grams of zinc. As it was necessary for our work to go below this, some such concentration method as was used for germanium had to be devised.

Thallous salts, which are the stable form, are oxidized and precipitated by permanganate in neutral solution. Using manganous manganese, which also precipitates under these conditions, as a collector, we found this procedure practical for concentrating the thallium.

The manganese dioxide precipitate, containing the thallium as Tl_2O_3, is transferred to a small beaker, dissolved in concentrated hydrochloric acid, and evaporated to dryness. The spectrum of the powdered $MnCl_2$ is then photographed in the usual manner. In this test, however, we found that the spectrum of manganese was so intense that the slower "process" plate registered it well with an exposure of 20 seconds. This plate and exposure were accordingly used for thallium. Development is the same as was indicated for the 33 plate.

This spectrum is peculiar in that the carbon bands are almost completely suppressed. This enabled us to use the thallium line 3519.2, previously masked. The nearest manganese line to it which fades out within the limits of the plate-holder opening is 3330.6. This was used as the control line. See Fig. 5.



Spectra of the standards

Difficulties

The failures should be recorded with the successes, particularly as these failures are very instructive. We had intended, when this work begun, to include copper, cobalt, and iron with the metals to be determined with the spectrograph, but this proved impossible, in each case for a different reason.

In the copper analysis, in the range 4220 to 2700 I.A., the *raies ultimes* 3273.9 and 3247.5 are of extraordinary sensitivity, being detectable when the copper concentration is as low as one part in ten million. But the next most sensitive line, 2824.4, appears only at a comparatively high concentration, so there is a considerable gap between the

raies ultimes and this line. In the wedge spectrum the two sensitive lines have traveled across the plate-holder opening, and are therefore useless for measurement, long before 2844.4 appears. This gap makes the determination of copper impossible for concentrations below the sensitivity of the line 2824.4. Another difficulty is that copper is such a universal impurity that no material suitable for electrodes has been found which does not contain it.

Our failure with cobalt was for an altogether different reason. For the range of concentration of cobalt in which we were interested—namely, 0.5 to 50 mg. per 100 grams of zinc—the only lines appearing are 3453.5 and 3405.1. These lines, even in the spectrum of pure cobalt sulphate, are not very intense, and their intensity with decreasing concentration changes so slowly that the variation in length is not sufficient for practical use. The slope of the curve is so nearly horizontal that a slight error in measuring the length of the wedge line means a large error in the result, so that the determination is no better than a guess.

In the experiments with iron, the trouble could be ascribed to impure electrodes. Our electrodes often contained more iron than our samples did, so that this determination was out of the question. We have since learned that this difficulty could be overcome by using Acheson graphite electrodes, which are practically free from iron. However, one must remember that the iron spectrum is like that of cobalt in containing no very intense lines, so that even if the difficulty due to impure electrodes be overcome, the trouble introduced by lines which change too slowly with change of concentration would still remain.

Discussion

In the foregoing we have described our methods of using the spectrograph to determine four metals in zinc and concentrated zinc sulphate solutions of high purity. An account of our experience with this method in the matters of rapidity, cost, and accuracy, and a discussion of the possibilites of extending the procedure to take in the quantitative determination of traces in any kind of sample, may properly be recorded to supplement the record.

As to speed, this is an advantage conceded to the spectrograph. The wedge spectra method is particularly fast, compared with the older methods, because outside standards are not used and only one exposure is required. When necessary to turn out a determination in the least possible time, the work can be organized to that end. Besides the obvious steps of having the apparatus and developing solution in readiness, the plate, after exposure and development, need not be fixed completely, but can be taken out of the hypo bath as soon as the unexposed portions have been dissolved away—about two minutes—and measured wet by a micrometer magnifier working at a distance from the plate surface. With this arrangement the time for a determination, starting with a dry sample, need be only 8 to 10 min. Starting with a wet sample, the additional time for evaporation is not important, as only a small amount of sample is necessary. This advantage of speed permits the method to be used as a plant test, in the control of such operations as involve the removal of a metal below an arbitrary concentration.

On the other hand, if speed is not a consideration, preparation of samples, and exposure and development of plates, can be done in batches. A fair day's work is 30 to 40 exposures, provided preparation of samples requires no more than evaporation.

The cost of "reagents," which, in the work here described, consist of electrodes and photographic plates, is ridiculously low. They total about 15c. for a plate containing five exposures, and more than one metal may be determined by an exposure. Conversely, trace analysis by chemical means is usually very costly in the outlay for reagents, because of the large samples taken to have a workable quantity of the element for the final measurement, and because of the high quality of reagents necessary for this type of analysis. Costs, therefore, in spite of the expensive apparatus used, are in favor of the spectrograph where the volume of work justifies its use.

As to accuracy, the method was given a thorough trial by running samples parallel with the smelter assay office. In addition, frequent blind synthetic samples were submitted, and other means for checking, such as metal balances, were resorted to as opportunity offered. The table gives results representative of our experience.

Results Obtained With Spectrograph and in Assay Office

Sample	*Assay Office* Cadmium Mg./110 Grams of Zinc	*Spectrograph* Cadmium Mg./110 Grams of Zinc
Purified Solution 8B	4.8	4
Purified Solution 9	2.3	4
Purified Solution 10A	3.5	4
Purified Solution 10B	22.4	23
Purified Solution 11	13.4	14
Purified Solution 12	12.8	13
Purified Solution 18	21.0	23
Purified Solution 25	78	100
Purified Solution 27	72	100
Purified Solution 28	92	86

In general, experience showed that the error was within 10 per cent for the majority of determinations, with occasional errors up to 20 per cent. But absurdly large errors never occurred with the spectrograph, although they sometimes happened with the chemical method. For the very low concentrations dealt with here, this error is not large.

Our procedure departs from that of Twyman and Fitch in only one important particular — namely, we used salts instead of metals for samples. But this change, though apparently trifling, has led to certain decided gains. In the first place, preparation of standards is easy with salts and difficult with metals. In the second place, concentration of a metal up to a determinable range, as with germanium, is possible. In the third place, where the base material interferes with the determination, it can be changed to a base which does not interfere, as was the case with thallium.

This last factor, if its potentialities are explored, may open a whole new field for the spectrograph as a quantitative instrument. At present the principal drawback of spectrographic analysis is that it lacks versatility; for instance, a method for determining cadmium in zinc sulphate cannot be used for determining cadmium in copper sulphate, or in any other salt but zinc sulphate. The difficulty lies in the requirement that the base material in both the sample and the standards from which the standardization curve was derived be nearly alike in composition. Now, as long as the final sample is to be in the form of a salt, this difficulty could be overcome quite simply by a chemical separation, as we did with germanium and thallium.

The Procedure

Circumstances prevented us from following this scheme further, but it is here set down in the hope that others will continue the work. The plan is to divide the metals into groups by means of group reagents, exactly as is done in qualitative analysis, adding prior to precipitation a known amount of a metal which acts as a collector during the separation and later as the base material during the exposure in the spectrograph. The measurement of the resulting spectrogram gives the ratio of unknown metal per unit weight of base, and as the amount of the latter is known, the percentage of the unknown metal in the original sample can be calculated.

The collectors which we have already employed—namely, CuS and MnO_2—will probably be found suitable, the former for most of the hydrogen sulphide group metals, and the latter for the group containing iron, cobalt, nickel, and thallium. The new organic precipitants should also prove valuable in this connection. In fact, from our present knowledge there is every reason to believe that a scheme of procedure could be devised which will embrace practically every type of sample likely to be met.

Finally, I wish to acknowledge with thanks the aid given me by Mr. O. C. Ralston, director of research, on whose broad experience I frequently drew, and Mr. C. R. Kuzell, superintendent of the United Verde Copper Company, who did not hesitate to try a new method, and with whose permission this paper is published.

Three and a Quarter Centuries of

Successful Exploration by U.S. Geological Survey Results in the Development of Enterprises Able to Compete for Domestic Market

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THE year 1933 may be appropriately celebrated as the 325th year of an endeavor to produce in America potash for domestic needs, for it is recorded[1] that in 1608 the London Company included with its colonists Poles and Germans "to produce soap ashes and other chemicals."

The early American potash industry was dependent upon wood ashes, and potash was made from wood ashes at Piscataqua, N. H., as early as 1631 and in Maine a few years later. South Carolina in 1707 subsidized the production and exportation of potash, but on account of the low potash content of the trees in the South Atlantic states her hopes were doomed to disappointment. Massachusetts in 1735 enacted measures to encourage potash production and in 1741 granted a limited monopoly. This was followed by a monopoly in Rhode Island in 1753.

As early as 1750 American potash was found in English markets, and it was soon given encouragement by being entered duty free, largely through the efforts of Thomas Stephens, a producer of potash in the Colonies, who was awarded a grant of £3,000 "for his experience in introducing the manufacture of potash in the British Plantation in America."

So little potash was produced during the Revolutionary War period, in spite of the great abundance of trees suitable for its manufacture, that at one time Massachusetts advertised a bounty of £100 a ton for potash manufactured in the United States, and potash was accepted in lieu of taxes.

During this time the manufacture of potash was understood by a relatively small group of men, and the products reaching England from different parts of the world ranged from poorly processed wood ashes to high-quality salts. Moreover, the price fluctuated greatly, at times stimulating and at times stifling production. The chief periods of export from America during Colonial times were between 1752 and 1757 and between 1764 and 1773, when the annual value of the exported salts was about $250,000.

From the Revolutionary War until after the Civil War the value of the American potash exports increased greatly, and, except for a few years, ranged in total annual value from $500,000 to $2,000,000 and in price from about $100 to $200 a ton. According to the census of 1850, production of potash was America's most thriving chemical industry. At that time 569 plants were reported producing potash from wood ashes. Curiously enough, France, from which the United States now imports considerable potash, was then our best customer.

Yields From Wood

According to C. E. Moore, in the report of the Twelfth Census, 1900, the amount of potash obtainable from different kinds of trees varies considerably. The yield from chestnut was only 2 lb. from 5 tons of wood, but pine yielded 8, maple 18, and elm 39 lb. American production was stimulated by the movement of the population into areas having forests that furnished high yields of potash, such as those south of the St. Lawrence River and the Great Lakes, and continued to thrive until the end of the Civil War, when there was a great decline, attributable not so much to the cutting off of the timber as to the perfecting of the Le Blanc process for making soda ash and the substitution of sodium salts for potash in making soap for world trade as well as domestic trade. As late as 1900, 67 plants reported a production of 1,782 tons of K_2O from this source, declining until the World War, when it was again revived.

The American potash industry based on wood ashes did not have its prime importance in export trade, important as that may have been during the days when there was little to sell abroad and much to buy, but from early Colonial days its service to the American people in the manufacture of soap, chemicals, explosives, glass, dyes, and other materials was of far greater value. Some people still remember when the ash man used to drive through the streets of the towns of the Great Lakes states shouting "Soap for ashes!" and trading a cake of soap for two bushels of ashes.

The second stage in the demand for potash began with the discovery of potash by analysis of brine from a well started in 1839 near Stassfurt, Germany, while exploring for salt; also from the discovery of potash salts in a near-by shaft in 1857, and the determination in 1858 that the salts were valuable as a fertilizer soon after Liebig had published his research on that subject. Mineral potash was first utilized in 1860, when Dr. Frank established a factory near the Stassfurt shaft for the production of potash from these salts.

At first, as the crop production from virgin American soils declined, new fields were cleared and new territory was settled. This procedure could not be continued indefinitely, however, and in time potash became an agricultural necessity. As a fertilizer, wood ashes were largely incidental, and until the present time the United States has depended largely on German potash for agriculture.

Search for New Sources

The search for new sources of potash in America has been a long and persevering task, particularly since 1910, when Germany, to maintain its prices and its monopoly, passed certain restrictive laws that in effect required American purchasers to surrender advantageous contracts. This action aroused the American Congress, and consequently in 1911 an act was passed providing funds to search for domestic sources of potash and to perfect processes of extraction of potash from various types of materials. This act provided the basis

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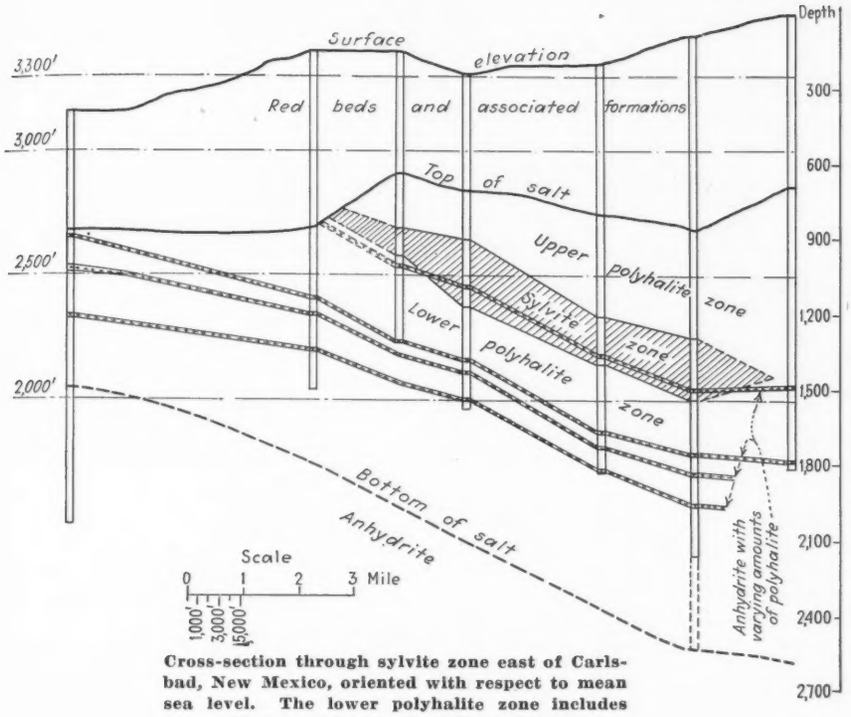
[1]Krepp, T. J.: "Vicissitudes of the American Potash Industry," *Journal Economic and Business History*, August, 1931.

the Potash Industry in America



Cross-section through sylvite zone east of Carlsbad, New Mexico, oriented with respect to mean sea level. The lower polyhalite zone includes three prominent anhydrite members

for the systematic search by the Geological Survey and other government agencies that has been in progress ever since. The Geological Survey has sought mainly for suitable supplies of natural soluble potassium salts. The search has now culminated in the finding of adequate reserves of soluble mineral potash and the beginning of a potash industry in this country capable of competing with the foreign producers. Total expenditure by the Geological Survey since 1910 and the Bureau of Mines since 1926 in the search for potash has been about $750,000. This sum is less than the value of the first full year's production from a mine recently developed in New Mexico as an outgrowth of the Congressional act mentioned in the foregoing.

When Germany placed an embargo on potash, Jan. 30, 1915, investigations of domestic sources of potash were fortunately well under way. Potash had been discovered in brines of deep wells drilled in Texas; in the western lakes of Nebraska; in Albert Lake, Oregon; Searles, Mono, and Owens lakes, California; and in marsh lands in Nevada, Texas, and California. Studies had been made of deposits of leucite in Wyoming, alunite in Utah, greensands in New Jersey, and feldspar in different states, salt deposits from East to West, and potash available in dust from cement mills. Studies had also been made by other agencies of organic substances such as sugar-beet wastes, kelp, wood ashes, distillery wastes, and wool scourings.

By 1915 wood ashes had definitely ended their three centuries of dominance as a source of potash in America, and had been supplanted by brines; but the production of potash from brines will soon be superseded by production from soluble mineral potash salts.

Aided by the information already gathered by the Geological Survey, the American consumers of potash readily turned to known sources to supply their needs. The recovery of potash from any of these sources was slow to get under way. However, stimulated by prices five to ten times those of pre-War years, American producers supplied a notable amount of potash until imports again became available.

As might have been expected, many promotional schemes were organized to capitalize the potash shortage during the War period, though without chances of permanent success. As early as 1915, potash was produced from Nebraska brines, Utah alunite, California cement-plant dusts, California kelp, and wood ashes from several states.

War-time Production Summarized

The futility of attempting to supply American potash needs from organic substances and from mineral industrial wastes is well illustrated in our War experience. With few exceptions all plants utilizing these sources ceased operating when or before the price of potash dropped to $200 a ton.

Investigations of marshes and dry lakes as a source of potash were well worth while, inasmuch as most of our potash used during the War was produced from such places.

In 1918 potash was produced in 21 states and Puerto Rico by 128 plants, which yielded 54,803 tons of K_2O, the greatest amount ever produced in America up to that time. Nebraska furnished 53 per cent of the total, California 34, Utah 7, and the other eighteen states and Puerto Rico 6 per cent. Brines were the principal source of potash being utilized by 27 plants, of which 19 were in Nebraska. These plants produced 24,330 tons of potash, or 73 per cent of the total American production. Kelp supplied 9 per cent; molasses distillery waste 6; alunite 5; cement and blast-furnace dusts, beet-sugar water, wood ashes, wool washings, and other sources 7. The total output in 1918 represented about 22 per cent of our normal annual consumption. Of the 128 producers, 51 reported potash from wood ashes, but they produced only 673 tons, or less than 8 producers obtained from Steffens water from beet-sugar refineries. The average yield per plant from wood ashes was only 13 tons, as compared with an average of 1,471 tons for the 27 plants producing from brines. Alunite, with 655 tons per plant for the 4 plants, showed the second highest average yield.

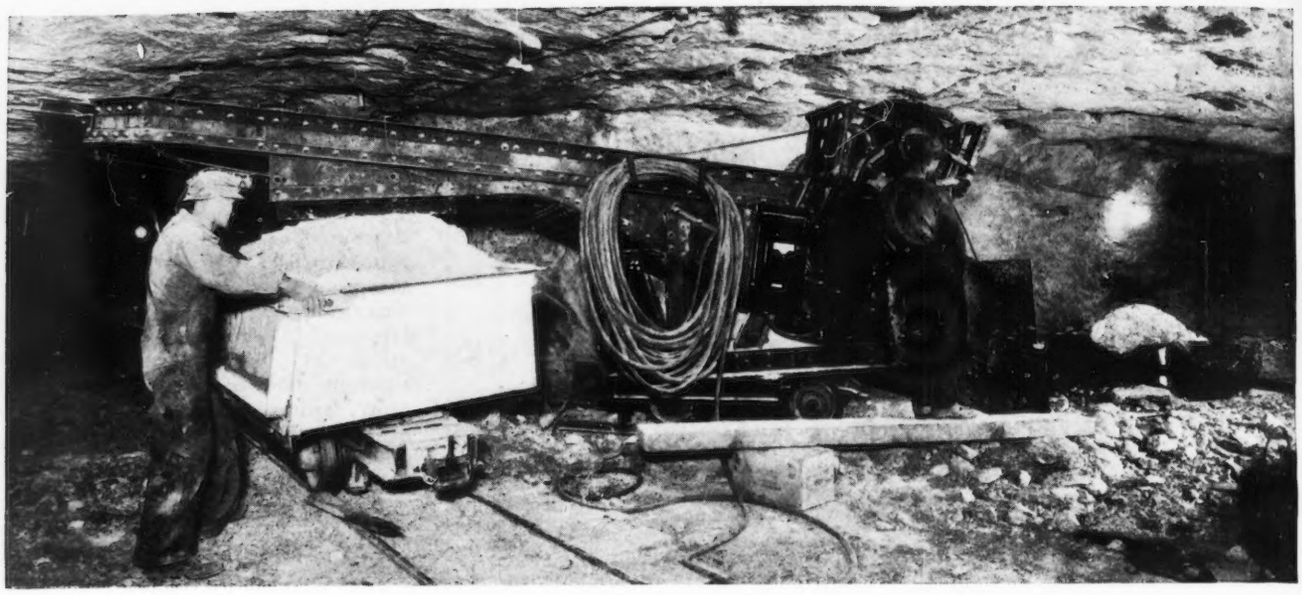
Subsurface Exploration

Subsurface exploration for soluble potash salts and brine deposits was begun by the Geological Survey in 1911 near Fallon, Nev., in what was formerly Lake Lahontan. By the end of the drilling program in 1917 it had drilled at Timber Lake, Silver Peak Marsh, Columbus Marsh, Black Rock, and Smoke Creek Desert, Nevada, and at the south end of Death Valley, California.

Examinations were made also of samples from wells drilled in Deep Springs Valley near Muroc station, and at Cadiz Lake, California, and in Railroad and Dixie valleys and at Ash Meadows, Nev. Numerous salt deposits, particularly in the eastern half of the United States, were also investigated.

The occurrence of potash in surface brines in the trans-Pecos area, Texas, was mentioned in 1904,[2] and one of the salt deposits to gain early attention was the Permian salt basin, in Texas and New Mexico, one of the very large salt deposits of the world. Attention was drawn to the subsurface possibilities of this basin by the Survey in 1910, in the first volume of Mineral Resources that contained a chapter on potash. Two years later, potash was reported in the

[2]Richardson, G. B.: U. S. Geological Survey Bulletin 260. Pp. 578, 1904.



Scraper loader operating underground in United States Potash Company's mine. Courtesy C. A. Pierce

brines of the well at Spur, Texas, by J. A. Udden. The search for potash in oil-well cuttings, brines, and core tests in this basin has been continuous since that time. Many are familiar with the reports by Survey geologists, White, Steiger, Hoots, Darton, Lang, Mansfield, and Schaller, on the progressive steps in the investigations that preceded the present developments.

After several years of intensive study, representatives of the Geological Survey, in cooperation with the University of Texas, selected a site near Cliffside, Texas, to drill for potash. This site was in that part of the basin showing the best indications for potash up to that time. The test hole, completed at a depth of 1,703 ft. late in 1917, was disappointing. In the meantime the E. J. Longyear Company drilled a core test hole for private interests near Carlsbad, New Mexico, near the western edge of the salt basin and a few miles southwest of where the United States Potash Company later discovered potash. No potash minerals were found, but a location a few miles farther east would have been exceedingly valuable in 1917.

The first soluble mineral potash salt identified from deposits in the United States was polyhalite. This identification was made by R. K. Bailey, of the Geological Survey, Feb. 17, 1921, in samples from the Bryant well, near Midland, Texas. In 1924 a sample of drill cuttings from the Crescent Eagle well, east of Green River, Utah, was turned over to the Geological Survey by A. G. Burnett and identified by R. K. Bailey as carnallite. This was the first time an occurrence of this mineral had been reported from American sources. A month later a sample from Texas that had been privately identified as sylvite was sent in by D. C. Barton, and this identification was confirmed in the Geological Survey. Early in 1925 a sample from a greater depth in the Crescent Eagle well was examined and found to contain sylvite. Only a few months later potash was found in a well drilled by the Snowden-McSweeney Oil Company on a government oil and gas permit held by V. H. McNutt. An abundance of polyhalite and a small quantity of sylvite were identified by Bailey in cuttings from this well. Previous to drilling this hole neither of these minerals had been reported from New Mexico sources. The discoveries in Texas and Utah did little to invite core drilling, but the discovery in New Mexico, in beds less than 2,000 ft. deep, stimulated intensive exploration by diamond drilling.

The first core test hole drilled by Snowden-McSweeney for potash was started April 14, 1926. In June the Federal potash exploration act was approved, and late in July the first government drilling locations were made in New Mexico.

Results of Drilling

As a result of drilling to date, the area in which some potash minerals have been found within the Permian Basin constitutes about 40,000 sq.mi.[3] In this one core test hole has been drilled for about each 500 sq.mi. The area considered most promising for potash minerals other than polyhalite covers about 3,000 sq.mi., in which one core test hole has been drilled for each 50 sq.mi. In 100 sq.mi. of this area one hole has been drilled to each 2 sq.mi., and 33 sq.mi. has been proved to contain as much as 14 per cent of K_2O in the form of sylvite in beds 4 ft. or more in thickness. This area of 33 sq.mi., small as it may seem, is more than half the size of the area under development for potash in France. Only a few square miles contain salts that can be sold without enrichment in competition with imported manure salts.

The zones of enrichment are numerous and vary in richness and thickness. The term "beds" has been used to designate zones where the potash salts are concentrated, and I have distinguished 40 such beds that have been cut by the drill in the proved area, half of which are above the anhydrite in the sylvite zone shown on the accompanying cross-section.

The sylvite zone at the shaft contains a section of 82 ft. and another of 58 ft. that average about 9 per cent K_2O. The bottom 10 ft. ranges from 25 to 30 per cent of K_2O over the area, which is now being mined.

Considering that more than $1,000,000 has been spent by government and private agencies in core drilling for potash in the Permian salt basin of New Mexico and Texas, and that the cuttings from many other wells have been examined, any proposed new prospecting for potash must be considered highly speculative, even with the definite information now available.

The most attractive deposits of sylvite, carnallite, polyhalite, and langbeinite so far found in the Permian Basin lie within the 100 sq.mi. of prospected land east of Carlsbad. The sylvite deposits that are over 4 ft. thick and contain over 14 per cent of K_2O provide a reserve estimated at more than 100,000,000 tons of K_2O. Carnallite is not considered of present value except as a source of salts for drilling solution. The best showing of carnallite is the bed which I have designated No. 17 and which is cut by the United States Potash Company's shaft. Langbeinite is found in the lower sylvite zone, but except in two or three localities is of low grade.

Polyhalite is the most abundant of the potash minerals, both in number of beds

[3] Mansfield, G. R., and Lang, W. B.: "Government Potash Exploration in Texas and New Mexico." A.I.M.E. Technical Publication 212, 1929.

and in extent of deposits. However, polyhalite in a single bed over 4 ft. thick and containing over 12 per cent of K_2O has not been proved to be continuous over a very large area. One reason for this is that the development of polyhalite has not yet been seriously considered, and as some of the most promising polyhalite deposits lie some distance below the lower sylvite zone, and only a few holes have been cored deeply enough to test these lower beds, more prospecting

Composition of Potash Minerals Found in New Mexico Area

(According to Dana)

Polyhalite	$K_2SO_4.MgSO.2CaSo_4+2H_2O$ 28.9% K_2SO_4 15.6% K_2O
Langbeinite	$K_2SO_4.2MgSO_4$ 42.1% K_2SO_4
Sylvite	KCl 52.4% K
Carnallite	$KCl.MgCl_2+6H_2O$ 26.8% KCl

is needed before any area can be considered proved sufficiently to open a mine solely for polyhalite. The polyhalite beds vary in thickness and in the amount of anhydrite present. Within short distances a rich polyhalite bed may change to one with a high percentage of anhydrite, and for this reason closer drilling may be needed than has been required for sylvite before reliable estimates of reserves of polyhalite can be made. There can be little doubt of the adequacy of reserves of polyhalite to meet requirements when a demand is developed for this mineral. One of the best polyhalite beds so far found was cut at a depth of 1,250 ft. in a private core. It is 9 ft. thick and averages 13.5 per cent of K_2O.

With the known reserves in New Mexico and the reserves in Searles Lake it is doubtful if the other potash resources exploited during the World War will again assume commercial importance unless the potash should become a component or byproduct salt.

The technique of core drilling in the Permian salt beds developed as drilling progressed. Diamond, bort, and stellite bits were used. A 2½-in. double-core barrel containing special features for a minimum circulation on the cut core was worked out in the early drilling for the Snowden-McSweeney company and has been used with modifications in drilling since that time. The drilling solution likewise was improved progressively. Longyear tried oil and then salt brines as a circulating solution. The solution used in later drilling in New Mexico consisted of a saturated solution of sodium and magnesium chloride. The importance of constant control to see that the solution was kept at full strength was not always appreciated. Late in 1930 potassium chloride was added, and in 1931, in place of purchasing high-priced potassium and sodium chloride, the salts from the United States Potash Company's mine were used to make a saturated solution, to which magnesium chloride was added. This was further improved by requiring the drillers to preheat the solution prior to circulation. Mud has even been added in new solutions in the belief that etching of the cores would thereby be reduced. Dependence for good core is now placed on close control of the saturation of the solution.

Gas and Water Encountered in Shaft Sinking

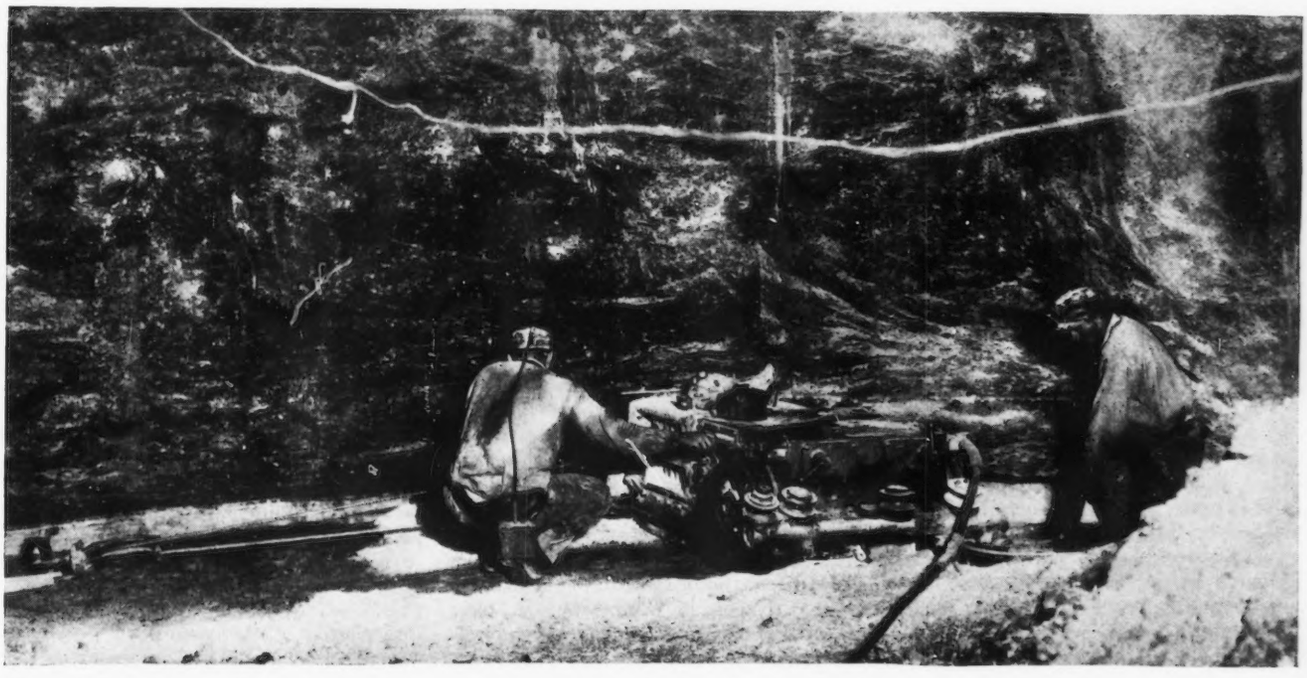
The No. 1 shaft of the United States Potash Company is 20 ft. 4 in. by 5 ft. 6 in. inside of the timber. It is divided into four compartments and is 1,062 ft. deep. It was sunk 80 ft. below the mine workings to provide an ore pocket and opportunity for skip loading. It was started in December, 1929, and the first shipment of potash was made in January, 1930.

In sinking, air-hammer machines with non-rotating chisel bits, similar to those used in tearing up street paving, were used. These hammers were found to work satisfactorily in the soft formations and eliminated the necessity of shooting, which greatly reduced the shattering effect on the shaft wall and permitted excavating within shaft dimensions. About 50 gal. of water a minute was struck in the upper formations, and a water tunnel was driven nearly around the shaft and a sump and pump were placed in it.

Gas high in nitrogen, with appreciable quantities of methane and hydrogen, and under heavy pressure, was encountered when certain polyhalite beds were cut, but the pressure was soon dissipated after the round was shot. This gas was flammable when mixed with air, but by fortunate circumstance and skillful handling no injuries occurred. The presence of hydrogen, which is found also in European potash mines, though not in coal mines, is an interesting feature.

The shaft was lined with Port Orford cedar. The air compartment was first separated from the hoisting compartments with wood, but this was later changed to sheet-metal lining. On completion of Shaft 2, the shaft is to be fireproofed.

Shaft 2, about 2,000 ft. south of Shaft 1, is 15 ft. 10 in. by 5 ft. 6 in. inside of timbers and has three compartments. It was sunk to a depth of 955 ft. since July, 1932, and was connected to the main south entries from the No. 1 shaft on June 14. The limitation of the number of men permitted in the mine at one



Face in United States Potash Company's mine drilled for shooting and being undercut by electric undercutter. Courtesy C. A. Pierce

time, prior to the completion of a second means of escape, will be removed and the mine permitted to operate at full capacity as soon as the necessary changes are made in the ventilation. Prior to reaching the water sands in this shaft two holes were drilled about 15 ft. north and south of the shaft site and grouted, in an attempt to test and partly seal the water-bearing strata, and when the shaft was sunk to a depth of 183 ft., two series of holes were drilled to complete cementing off the water. In sealing the water in the formation 253 tons of mud, 2½ tons of excelsior and cotton hulls, and 4,600 sacks of cement were pumped into the formation. The shaft was then sunk through the water-bearing formation, and a 65-ft. section of concrete lining was put in from 230 to 295 ft. This concrete lining ranged in thickness from 36 in. at the bottom to a minimum of 12 in. at higher levels.

The third shaft in the field is being sunk by the Potash Company of America. This shaft was started Feb. 11, 1933. Unless delayed in sealing out the water, this company should also begin production this year, and thus become the second large enterprise depending entirely on potash for its output and the third potential source for large tonnage in the United States.

Production Capacity Equal to Demand

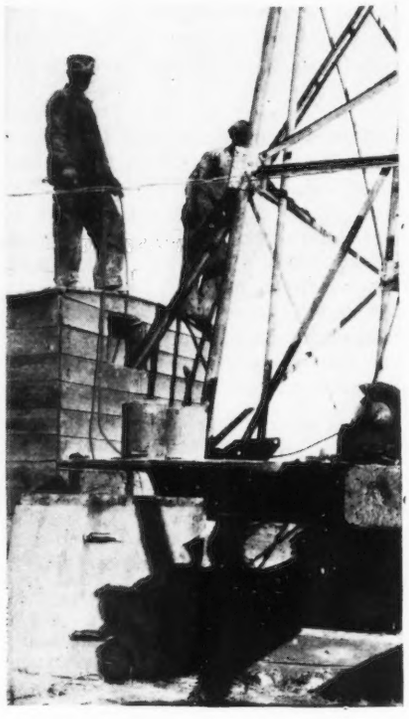
Potash deposits in New Mexico lie relatively flat and in such manner that they can be readily mined by the room-and-pillar system. The crude salts are of a grade suitable for market after grinding as 25 to 30 per cent manure salts. To meet any emergency the United States Potash Company stored about 30,000 tons in the open during the summer of 1932, to be ground and shipped or refined as occasion demanded. The capacity of the mine is ample to meet any anticipated demand. The refinery, 16 mi. from the mine, has been operated at a capacity considerably over 100 tons daily, and the product is meeting the requirements of the chemical as well as the fertilizer trade.

With the completion of the shaft of the Potash Company of America, New Mexico has a better opportunity than others to hold the production unless unfavorable freight rates, taxes, and royalties should stimulate development elsewhere. The royalties under State leases are usually 5 per cent, and the State receives 37½ per cent of the royalties collected by the government.

The importance of the potash deposits to the railroads is indicated by the fact that the product from the United States Potash Company's mine during July, August, and September, 1932, was handled by 33 different railroads on its way to chemical or fertilizer factories. Shippers by water have likewise been benefited.

The market trend with respect to the grade of salts imported prior to 1932 is reflected in the decline of imports of kainite and manure salts. Imports of kainite dropped from over 600,000 tons in 1910 and 1911 to 113,938 tons in 1932. Manure salts reached its peak in 1928, with 453,242 tons; sulphate in 1930, with 96,608 tons; muriate in 1931, with 306,047 tons. These maximum figures may be compared with total imports for fertilizer of 287,929 tons for 1932, which is only slightly more than twice the American production of 143,120 tons and less imports than for any other year since 1921.

The capacity of the Searles Lake refinery, in California, may be increased 50 per cent on the completion of construction now suspended. As only a few months' time is required to construct new refineries or add additional units, American producers are in a position to contract up to the full American demands for potassium chloride salts, except for low-grade salts that have a value less than the mining costs and freight to market. The American sulphate salts in their natural state are at the border line of value between freight cost and selling price and are possibly of too low grade to complete with imported salts without lower freight rates or some enrichment.



To keep information on cores confidential the core barrel is put through the end of the core-house before the core is removed

No effort has been made by American producers to enter the sulphate market, so that European producers still have no competition in the field of the sulphate and the low-grade salts.

The fact that the price of potash in American markets after the World War did not increase in proportion to the cost of other commodities caused a large saving to the American consumer. But the question arises whether the low prices resulted from the long-established policy of a certain group in Germany who believe in low prices and increased production, or whether they have been maintained low to discourage development in America, Russia, Poland, Spain, and the Dead Sea. The fact that there was no premium on potash immediately after the World War, and that those producing here were forced to cease operations before having a chance to adjust their operations gradually to a rapidly falling price, may have some significance. New operations certainly were discouraged by this fall in price.

The present American situation is encouraging in that our resources are sufficiently large to eliminate all fear of a lack of supply of potash of a grade sufficiently high to meet any price that may be set abroad, short of dumping, and that the American farmer will get a higher potash content in his mixed fertilizers without a proportionately increased cost.

Sulphur Near Potash Beds in New Mexico

We still lack potassium sulphate, but this is no problem, as natural sulphur deposits are reported to have been found close to the New Mexico potash development. Sulphuric acid is available at El Paso. Hydrogen sulphide gas in large quantities is being burned in the air at the Hobbs oil field, a short distance to the east. Sulphur is available along the Gulf Coast. Some one of these sources will be used when it is advisable to convert the potassium chloride to sulphate. Polyhalite is found over widespread areas and can be supplied to the sulphate market without refining, or, according to the Bureau of Mines, it can be treated in a reducing flame to yield potassium sulphide containing 77 per cent of K_2O, the cost of freight being thus greatly reduced. Polyhalite, either raw or enriched, can supply the necessary sulphate and magnesium salts when it becomes economical to do so.

American exports of potash salts increased from 15,532 tons in 1929 to 31,291 tons in 1931. The exports went largely from California and may reasonably be expected to increase in the Pacific markets.

In conclusion, potash is now a world commodity, like nitrate and phosphates, and its production is no longer under the control of a single nation.

Acknowledgment is made in the preparation of this paper for references furnished by T. C. Cramer, chief chemist of the United States Potash Company, and for assistance in the preparation of the paper to G. R. Mansfield, geologist of the Geological Survey.

Plant of Antamok Goldfields Mining Company, Baguio district, Philippine Islands

GOLD

IN THE PHILIPPINES

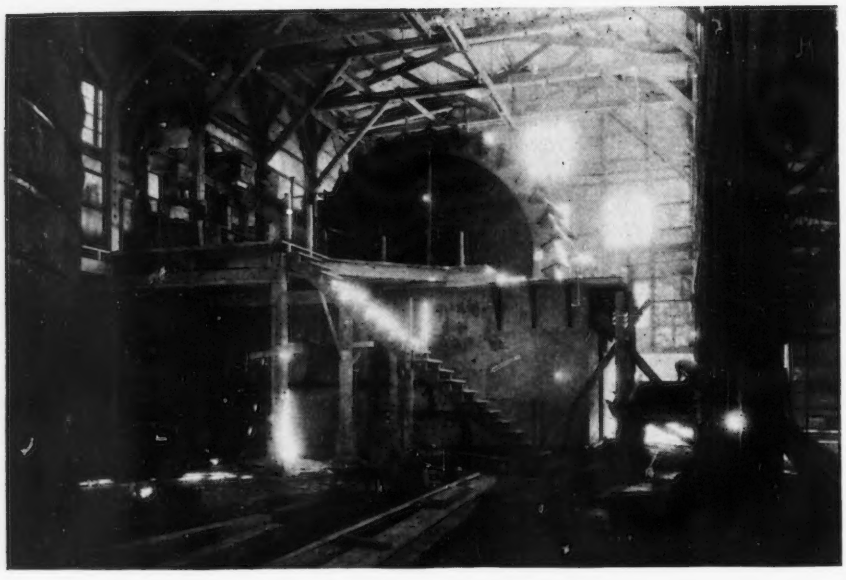
Mining Operations Steadily Expand—Premium Stimulates Activity.

GOLD MINING in the Philippines has been rapidly expanding in the last four years. An added stimulus has been given this activity by the increased price of the metal, in consequence of which the search for new properties proceeds apace. Outstanding among the producing areas is the Baguio district. Here there are now six producing properties, the latest to contribute its output being the Baguio mine, which began in September. The other five are: Benguet Consolidated Mining Company, the Balatoc Mining Company, the Itogon Mining Company, the [illegible] Goldfields Mining Company, and Benguet Exploration, Inc.

Of these the three oldest are the Benguet, the Balatoc, and the Itogon. Benguet Consolidated is enlarging its mill from 500 to 600 tons by adding a ball mill, classifier, and filter; Balatoc is putting in equipment which will raise its milling capacity to 900 tons. Expansion from 450 tons since January, 1933, has been made possible by the discovery of rich orebodies and by completion of a drain tunnel which enables 700 tons of ore to be brought to the mill site every ten hours.

Gold output of the Benguet company has increased from 90,095 pesos in 1915 to 4,200,285 pesos in 1932. For the first half of this year, its production is valued at 2,267,433 pesos. Its ore reserves at June 30 last were 530,700 tons, valued at 13,280,000 pesos, despite a production valued at 13,347,021 pesos since Jan. 1, 1930. J. O. Greenan, manager, has recently resigned. During his administration the mill capacity was increased from 300 to 500 tons daily; the 320 and other orebodies were discovered; ore reserves were increased; and production established new high records. He also effected a marked reduction in operating costs.

Benguet Consolidated also controls Balatoc and has taken over the Ipo property, in Bulacan, consisting of 73 claims. The company is now equipping a 150-ton mill and developing the property, allowing the Ipo company to retain ownership of the mine. A second profit-sharing venture has been entered into with the Midas Gold Mining Association, whereby Benguet will ex-



Hadsel mill of 150-ton capacity, during installation by Antamok Goldfields company

plore, develop, and mill the ore in the Midas group, consisting of eight claims adjoining the Benguet property. Benguet has also recently decided to operate the Big Wedge property on a profit-sharing basis.

The Itagon Mining Company increased its mill capacity to 200 tons in 1933, declaring the payment of a second dividend of 5 per cent in April, 1933. Significant gain in the value of mill heads was made during the past year. Average value of ore being milled at present is $10.64.

Antamok Goldfields Mining Company started production in July with a 150-ton Hadsel mill, the first to be tried in the district. It is reported as operating successfully.

Baguio Gold Mining Company recently completed the installation of a 140-ton all-sliming cyanide mill, and started operations. It then proceeded to acquire the two leased properties, which it had been operating in addition to its own, this purchase having just been consummated. This will simplify

New 150-ton cyanide plant of Baguio Gold Mining Company, 5 km. from Baguio

the accounting and planning and remove other difficulties that have arisen from the complex situation.

Benguet Exploration, Inc., started operation with a 50-ton leaching plant last June. Total operating costs for the month were below $3,500, showing a net profit of $6,500. The next mine which is expected to install a mill is the Gold Creek Mining Corporation.

Several new companies have been formed to develop properties in northern Luzon. Among them are Gold River Mining Association; Mountain Goldfields, Inc.; Suyoc Consolidated; Albra Mining Company; Pine Ridge; Demonstration Gold Mines, Inc.; Benguet Goldfields, Southern Cross, Mabuhay, and Shevlin. Most of these have incorporated, and others are preparing to do so immediately, as this has been made compulsory by recent mining laws in the Philippines.

Plant of Balatoc Mining Company, near Baguio. About 1,000 men are employed in mine and mill

A Short Trip to the Mother Lode

California Engineers Visit Drift Mines, Cement Plants, and Quarries on Southern Extension

J. B. Huttl

JOURNEYS of observation are among the most interesting, as they may be the most valuable, experiences falling to the lot of professional men. In this respect the annual field meetings of the San Francisco section of the American Institute of Mining and Metallurgical Engineers are in a class by themselves, as few conventions offer such a combination of opportunities for sociability and fraternization, for visiting places of technical interest and for technical discussions, as do these. Traveling in a body, the party proceeds from point to point along the scheduled route, with lunches, dinners, to say nothing of a technical session or two, marking the intervals on the program.

This year the meeting was held on Oct. 14, 1933, and the route was laid through Calaveras and Tuolumne counties in California, which cover the southern extension of the Mother Lode. Among the places to be visited were the plant of the Calaveras Cement Company, at San Andreas; the gravel mine of the Calaveras Central Gold Mining Company, Ltd., near Angels Camp; the Vallecito Western gravel mine between Angels Camp and Vallecito; the marble quarries near Columbia; and the quarry and plant of the United States Lime Products Corporation at Sonora. As gold and cement are foremost among California's many mineral products, the selection of these mining districts was indeed a happy one. The enhanced price for gold, making possible profitable operation of mines hithereto closed or abandoned, has brought new life to once famous camps and towns. Not since the early-day mining development has every district on the Mother Lode shown such activity as at present. Each week brings new men into this field, and every corner of the country is being scoured by prospectors and engineers. If sufficient new capital can be interested, and with ample engineering talent and labor available, activities on the Mother Lode will be further accelerated.

Non-metallic minerals have attracted considerable attention in the Mother Lode region. Both dolomite and limestone occur in lenses in or contiguous to the Calaveras formation. The limestone lenses are of economic importance. They are of highly metamorphosed limestone, marble in part, and irregular in outline and size. North of Sonora, in the vicinity of Columbia, the marble and limestone deposits cover an extensive area which had been stripped in part by the early placer miners. Portions of this area are being exploited by two companies, the Columbia Marble Company, of San Francisco, and the Bell-Columbia Marble Company. Both companies are quarrying by standard channeling methods an excellent grade of white mottled marble.

Just south of Sonora a wide lens of limestone is being worked by the United Lime Products Corporation. The company produces and markets lime, hydrated lime, and fine-crushed lime. Limestone is mined from two quarries near the plant by the bench method. At the processing plant facilities are available for burning, hydrating, and crushing the mined rock. Lime burning is done in oil-fired kilns of the shaft type, equipped with steel hoppers and bottom-discharge doors actuated by a rack and pinion. A part of the burned lime is crushed in a grinder of the coffee-mill type and elevated to a lime-hydrating plant. Fine-crushed lime is prepared in a crushing plant containing a Williams hammer mill operating in closed circuit with a Hum-mer screen. The finished products are shipped over the Sierra Railroad to the Coast markets.

A Modern Plant

In Calaveras County the largest non-metallic enterprise is the modern plant of the Calaveras Cement Company just south of San Andreas. The plant was erected in 1926 and has a capacity of between 3,000 and 4,000 bbl. per day. It is a standard wet-process plant. The raw materials move in a straight line from the raw plant to the finishing plant while undergoing diverse treatment. Another noteworthy feature is the small number of belt conveyors and elevators used. Limestone is mined by open-pit methods from two quarries near by. The quarry faces vary from 35 to 50 ft., averaging 40 ft. and carrying little or no overburden. Blast holes are drilled with Armstrong churn drills, and for blockholing the occasional boulders jackhammers are used. Air for drilling is obtained from a central

Mill of Carson Hill Gold, at Melones

compressor plant. Broken rock is loaded by electric shovels into 18-ton steel cars, which are hauled to the plant by gasoline locomotives. Here a rotary dumper discharges each car into a 42-in. gyratory crusher, the product of which is conveyed to two 10-in. gyratory crushers to be reduced to 1½ in.

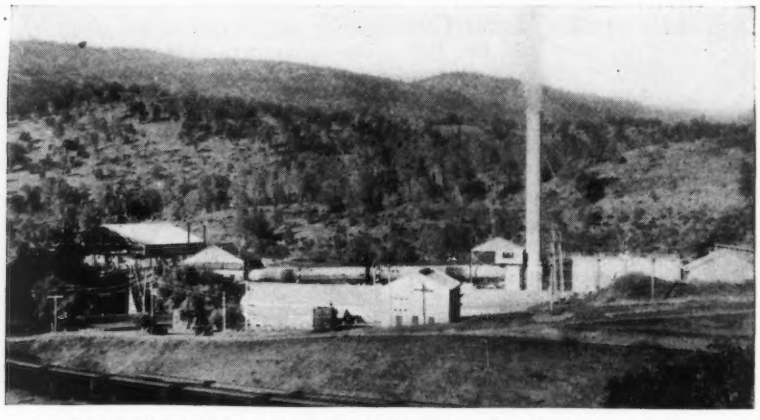
At the rock storage plant the rock is segregated and stored according to its lime content. The raw-grinding equipment consists of two 8x7x26-ft. Compeb mills, loaded in the feed end with balls ranging from 5 to 2½ in. in size, and with "Concavex" in the finishing end. They reduce the mill feed in one operation to 94 per cent minus 200 mesh, using about 33 per cent water. The mill discharge, or "slurry," flows to a concrete sump, whence it is pumped by air-operated pumps with electric valve control to the slurry-storage plant, consisting of eight hopper-bottomed concrete silos. Here a second air pump distributes the slurry, fills and drains each silo at will, and agitates the contents. From the silos the slurry flows by gravity to a series of correcting tanks, in which slurries from different silos are blended to produce a kiln feed of correct chemical composition.

The slurry is burned to clinker in two oil-fired rotary kilns, measuring 11 ft. 3 in. in the burning zone and 10 ft. for the remaining 240 ft. of length. Maximum temperature in the hot zone, where the slurry becomes fused to a clinker, is about 2,700 deg. F. The hot clinker drops into two 7x70-ft. rotary coolers in which the incoming air current is utilized to cool and preheat it for combustion in the kiln. These coolers discharge into a large storage bin served by an overhead crane which conveys clinker and gypsum to the respective feed bins in the finish-grinding plant.

Finish-grinding is done in two 8x26-ft. Compeb mills, the clinker being fed by table feeders and the gypsum by an automatically controlled ratchet-and-screw conveyor. The finished cement from the mills is elevated and distributed by a Fuller-Kinyon pump system to the

80-ft. concrete storage silos adjacent to the packing plant. Cement is withdrawn from these silos by screw conveyors and delivered to bins above three-spout Bates packers. Dust arresters are installed in the finish-grinding plant and in the packing and bag-handling plants. The Calaveras plant is almost entirely automatic in operation. Equipment and plant are of Allis-Chalmers make and design.

Drift mining or the exploitation of Tertiary channels—once the poor relative in the gold-mining industry—has attracted attention in recent years, and much has been done to revitalize it. The present-day miner has many advantages as compared with his predecessor, such as better knowledge of Tertiary channel geology and mechanical equipment for handling gravel and water. Ultimate success, of course, depends much



Plant of the Calaveras Cement Company, San Andreas, Calif.

on conservative and able management, as more than ordinary ability is required to unravel the erratic disposition of gravels. Ability to find channels that contain gold in paying quantities is the crux of the situation, involving much work. An advantage of drift mining is the comparatively simple plant required.

The principal incentive of drift miners in the Angels Camp-Vallecito area is the Central Hill channel. Of the numerous properties now active, the most important are the Vallecito Western, of Tonopah Belmont, at Vallecito, and the Victor mine, of Calaveras Central Gold Mining, west of Six-Mile Creek near Angels Camp. Both companies have done significant work and have proved several channels. Calaveras Central is developing five channels which appear to be extensions or arms of the Central Hill channel proper, according to Harry Sears, general manager. Operations at the Vallecito Western proceed satisfactorily under the direction of Fred Bradshaw, manager.

Calaveras Control is served by a 360-ft. three-compartment shaft sunk through 60 ft. of overburden. The uneven bedrock is chiefly slate. The filling consists of large boulders down to the fine interstitial material, which is sufficiently compact to make the workings self-supporting, but is not cemented enough to interfere with washing.

Haulage and drainage levels are 15 to 30 ft. below bedrock. All exploration and development work is carried on upstream, care being taken that proper drainage to the central sump is effected at all times. Exploration headings are usually driven between gravel and bedrock, which are followed by a haulage drift 15 ft. below. Loading chutes are established every 400 ft. Gravel handling costs have been materially reduced since the employment of Eimco-Finlay loaders.

Storage-battery locomotives are used in the main haulage drifts. Ground is broken with IR drifters and 35 per cent Hercules dynamite. The average round consists of 9 holes drilled 6 ft. deep. The gold is rather spottily distributed and, where found, occurs as a bedrock concentration, with values extending to a height of 6 ft. Daily tonnage obtained from development work is 125. Gold values average $4 a ton (gold at $20.67). Gravel and waste collected in the shaft loading pocket are hoisted in 2½-ton skips by a double-drum hoist. Compressed air is supplied by a Sullivan angle-compound compressor. A Stirling centrifugal pump installed in the lower shaft station discharges about 125,000 gal. per day.

Gravel is treated in a revolving trommel and a series of sluices in which baffles and riffles catch the gold. Trommel oversize is discharged upon a belt conveyor which delivers to the dump. Fines from the sluices are stocked for re-treatment. At present experiments are being conducted with a No. 6A-6, 12-riffle Huelsdonk concentrator handling 24 yd. per hour and consuming 20 hp. Water consumption is 150 g.p.m.

Reopening of the Carson Hill properties at Melones by Carson Hill Gold has given additional impetus to gold mining in the Calaveras-Tuolumne area. The new company, of which M. H. Manuel is president, has rehabilitated the mine, mill, and cyanide plant and is milling about 500 tons daily, averaging $3.25 per ton (old price). The mine has been examined and sampled by John A. Burgess, who states that about 4,000,000 tons ranging from $2.10 to $5 a ton are immediately available for exploitation in the Morgan glory holes and other known orebodies.

Surface plant, machinery, and haulage equipment are in good condition. At the mill, practice has been changed somewhat as compared with that employed in 1926, but part of the old equipment has been used. The ore milled is a medium-hard mineralized schist. Primary crushing is done in two 12x26-in. Sturtevant jaw crushers which discharge upon an inclined belt conveyor leading to the 2,000-ton mill bin. Following this, the ore is crushed to about 10 mesh by 30 1,200-lb. stamps, the mortar discharge flowing to three dewatering cones.

On the grinding and concentrating floor, one 6-ft. and two 8-ft. Hardinge pebble mills, and three Wilfley and nine Plat-O concentrating tables, are installed. Grinding is controlled by dilution and the 60-mesh product is concentrated in the manner practiced at the Brunswick mill of Idaho-Maryland at Grass Valley. The sulphides from the three Wilfley roughers, to which the discharge from each battery unit is sent, pass to three separate Plat-O tables. Gold and high-gravity sulphides are cut off them daily and collected in cans. Table concentrates flow to two dewatering cones, whence they pass first over a side-shaking amalgamation plate equipped with riffles, and then over an end-shaking plate prior to being fed to a 6-ft. Hardinge pebble mill. The mill discharge flows through three Hamilton amalgamators discharging into a Dorr classifier operating in closed circuit with a 4x13-ft. tube mill. Classifier overflow goes to a Plat-O concentrating table, from which a high-grade bluish streak containing small quantities of galena, tellurides, and arsenic, and assaying from $15,000 to $30,000 a ton, is cut off and collected in cans. Table tailing flows to the main tailings launder. Imported pebbles are used in all grinding mills.

The cyanide plant has been rehabilitated under the direction of F. A. Beauchamp, of Hamilton, Beauchamp & Woodworth. Tailings are pumped to a flume 1,500 ft. long discharging to one simplex and two duplex Dorr classifiers. The plus 200-mesh material is leached in seven 38-ft. 500-ton tanks. Slimes are thickened in four 38-ft. Dorr thickeners to a 1-to-1 pulp and pumped by diaphragm pumps to three 16x12-ft. agitators. From here the pulp passes to a storage tank and thence to a 12x16-ft. Oliver filter. Solutions are precipitated by zinc dust, the precipitate being treated with sulphuric acid and melted in a pot furnace with a high niter flux. The company plans to increase mill capacity to 1,000 tons a day. John A. Burgess is general manager.

Unusual Minerals

In Flotation Products At Cananea Mill Studied Quantitatively by Microscope

A. M. Gaudin

DEVELOPMENT of a new orebody reputedly containing considerable covellite at the Cananea Consolidated Copper Company's properties near Cananea, Sonora, Mexico, made it especially attractive to study quantitatively the products of the Cananea concentrator. This unusual interest arose, of course, from the fact that orebodies containing a substantial quantity of covellite are uncommon, so that little is known concerning the floatability of that copper mineral.

As the study of the Cananea specimens progressed, interest in the work increased to a marked degree. Many unusual minerals of the enargite and tetrahedrite groups were observed, together with molybdenite, whose value as a byproduct may eventually be capitalized. Many interesting observations were made as to the sequence of flotation, relative abundance, and mutual relationships and associations of the several minerals. These observations are of value not only from a dressing standpoint but also from the viewpoint of ore genesis. Indeed, the data secured by a study such as is recorded here may be considered as suggestive of a new approach to a solution of the problems of ore genesis, made possible by placing on a quantitative basis the relationship between minerals. From a dressing standpoint this study has suggested alternatives in flowsheet which look sufficiently promising to warrant extended tests.

Preparation of Samples

At the time the samples were taken the flowsheet of the flotation division of the plant was as shown in Fig. 1. Samples were taken of the froth coming from each cell during a period of one month under the supervision of A. T. Tye, assistant superintendent of the concentrator, whose outstanding cooperation is gratefully acknowledged. The samples were dried, bagged, and shipped to Butte.

From Fig. 1, it is seen that the flow of pulp from cell No. 1 to cell No. 25 is not complicated by middling returns of any sort. This is particularly fortunate from an investigative point of view, as it affords a picture of flotation operation in its greatest simplicity. A final concentrate was taken from cells No. 1, 2, and 3, and a middling from the remainder, the middling being cleaned and recleaned to yield an additional final concentrate and a product which was returned to the classifier preceding cell No. 1. Thus, frothing was carefully controlled and held back in the first three cells, but was vigorously prosecuted in the cells making a middling.

In view of the great apparent similarity between the various samples from cell No. 6 to cell No. 25, decision was made to limit the investigation to the samples from cells No. 1, 2, 3, 4, 5, 8, 14, and 25, it being assumed that the samples of froth from the remaining cells are intermediate in character. Experimental results have justified this policy of minimizing unessential routine work.

The selected samples were elutriated in water and acetone as described elsewhere.[1] Accuracy of the sizing effected in elutriators has already been proved at the Montana School of Mines by measurement under the microscope, the deviation between the observed and calculated average size not exceeding a few per cent.[2] Assumption is made, in view of the similarity in the sizing operation and of the greater experience of the testing operators, that the sizing in this investigation was satisfactorily accurate. The appearance under the microscope of the many products investigated gave no reason for dissatisfaction with it.

Fig. 2 presents the results of sizing. It brings out definitely the fact that the coarser particles float first. This, coupled with the low metal content of the froth from the cells near the tailing end of the machine, suggests that much of the mineral overflowing from these cells does so mechanically; that it is brought with the inter-bubble water rather than attached at bubble walls.

Briquets[3] were made of most of the sized products and the identification, counting, and recording of many thousand particles were completed on each briquet.

Chemical analyses for copper and iron were made of the products that were briqueted, as likewise of the finest (slime) products. Table I presents the copper analyses as calculated from the microscope data and as determined analytically. They are in accord. Table II presents the analyses for sulphide iron calculated from microscope data and for total iron, determined analytically. The discordance is probably due in part to the presence of ferrous silicates, in part to the presence of iron carbonates or oxides, and in part to an underestimation of the pyrite in the microscope observations, presumably because that mineral was torn from the briquets during polishing, on account of its high relief.

The Minerals

The following minerals were recorded in data sheets: "silicate," molybdenite, pyrite, chalcopyrite, chalcocite, bornite, covellite, "gray copper," and sphalerite.

In this classification molybdenite, pyrite, chalcopyrite, covellite, and sphalerite are genuine minerals. "Silicate" is a term that covers all the translucent

A contribution from the Ore Dressing Laboratories of the Montana School of Mines, Butte, Montana.

[1] A. M. Gaudin, J. O. Groh, and H. B. Henderson: "Sizing by Elutriation of Fine Ore-dressing Products." *Ind. & Eng. Chem.* 22, 1363-66 (1930).

[2] R. E. Head and Morris Slavin: "A New Development in the Preparation of Briquetted Mineral Grains." Tech. Paper No. 10, Utah Eng. Exp. Sta. (1930).

[3] A. M. Gaudin, "Flotation." McGraw-Hill Book Company (1932), p. 498.

gangue minerals. Chalcocite refers to the several varieties of copper glance, some of which are the pure Cu_2S, others the blue, solid solution of CuS in Cu_2S, and others the pinkish-gray, solid solution of bornite in chalcocite.[4] Several minerals having a bornite-like color were observed. All are included under the term bornite; whether or not they are the same species could not be ascertained. At least four different minerals are lumped under the leading "gray copper": one in pinkish gray, another pale gray, a third greenish gray and a fourth bluish gray. The absolute identity of these minerals is not known, but they belong to the groups of minerals which include several or all of the following: Tetrahedrite, tennantite, enargite, freibergite, famatinite, and luzonite, all of which are arsenic - antimony - bismuth sulpho-salts of copper, frequently silver-bearing.

No difficulty was met in identifying pyrite, chalcopyrite, or covellite, as the first named is the only opaque mineral to be characterized by high relief, and the colors of the other two are characteristic. Typical specimens of bornite and chalcocite were readily identified, but bornite holding chalcocite in solid solution and chalcocite holding bornite in solid solution are of various lavender-gray shades and can be confused with pink to lavender-colored "gray copper." Also, some chalcocite holding covellite in solid solution resembles the paler shades of pleochroic covellite. Identification of what is termed gray copper is difficult, as this term covers all particles ranging from a bright bluish or greenish gray (typical tennantite), through chalcocite-like pale gray and a darker shade of gray not unlike sphalerite, to a pale buff (typical tetrahedrite). Silicates were identified by the slight relief at the contact with bakelite, by the presence of light-reflecting inclusions, and by their slight color difference with the background. Etching was attempted, but although it clarified some distinctions, as for instance the chalcocite-gray copper separation, it made others less distinct. As a result etching was not employed, and identification was based altogether on natural color and relief.

After a briquet was polished satisfactorily, a quantitative mineragraphic analysis was made by identifying, counting, and recording from 1,500 to 5,000 particles, depending upon the general abundance of the various minerals in the briquet. Thus, in a concentrate product containing a large proportion of copper sulphide minerals, a count of as few as 1,500 particles was accepted, whereas on low-grade middling products a count of less than 5,000 particles was generally not sufficiently accurate. Special form sheets were devised for the recording of particles, and a me-

[4]Hans Schneiderhoehn and Paul Ramdohr: "Lehrbuch der Erzmikroskopie," Borntraeger Bros., Berlin (1931), Vol. 2, p. 277.

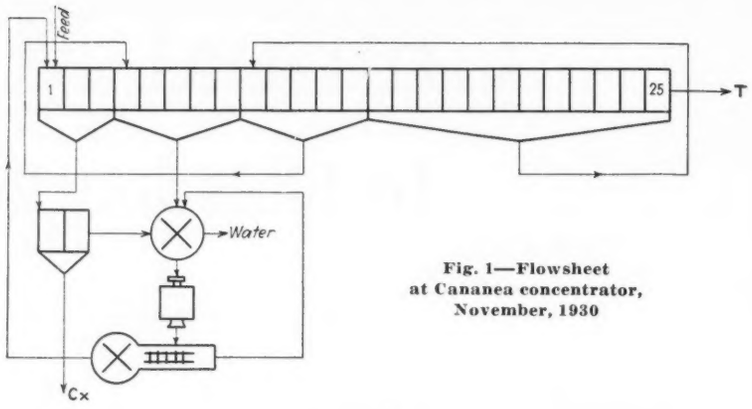


Fig. 1—Flowsheet at Cananea concentrator, November, 1930

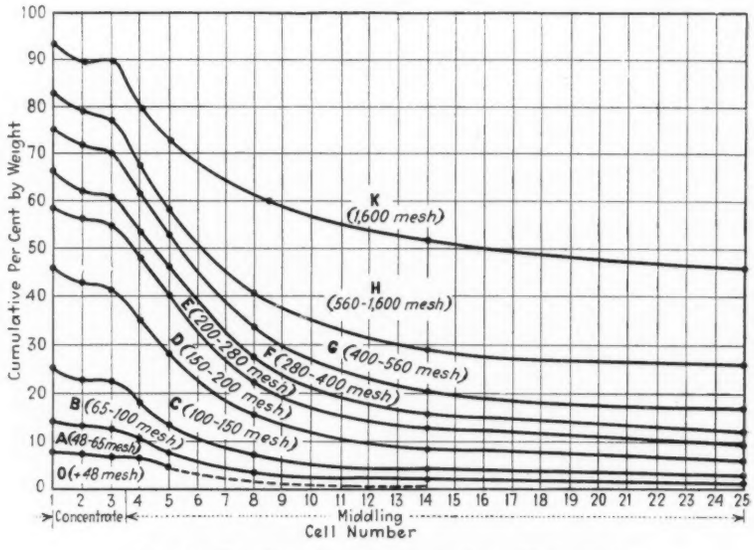


Fig. 2—Results of sizing operation. The curves show the size of froths from the various cells

Table I—Comparison of Percentage Copper Content According to Chemical Analysis and to Microscope Analysis*

Cell No.	1	2	3	4	5	8	14	25
A[48/65]	30.7 (32.0)	30.9 (30.3)	30.0 (30.7)	25.3	20.2	....	....	....
C[100/150]	30.3 (30.4)	29.0 (29.5)	27.0 (28.3)	17.6 (17.1)	13.0 (12.0)	5.5 (5.7)	2.6 (2.9)	0.6 (0.49)
E[200/280]	34.0 (33.8)	31.7 (32.0)	30.7 (29.9)	20.2 (19.4)	11.6	4.7	1.1	0.3
G[400/560]	31.7 (33.7)	34.3 (34.7)	31.8 (34.3)	22.0 (21.7)	13.5 (13.0)	3.2 (2.7)	0.9 (0.93)	0.2 (0.16)
K[−1600]	21.7	22.5	23.3	11.3	6.5	2.7	1.6	0.5

*Figures in parentheses in this table represent microscope analyses; the others, chemical analyses.

Table II—Comparison of Percentage Total Iron Determined Analytically, and of Percentage Sulphide Iron Calculated From Microscope Counts*

Size, mesh	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 8	Cell 14	Cell 25
A[48/65]	26.3 (24.8)	27.1 (25.1)	26.2 (23.3)	26.3	25.2	....	....	....
C[100/150]	23.0 (21.4)	23.1 (21.8)	22.9 (21.6)	23.3 (19.1)	20.6 (17.2)	19.5 (14.1)	19.0 (13.6)	5.7 (5.9)
E[200/280]	22.8 (22.0)	22.2 (22.3)	22.2 (22.3)	23.8 (22.5)	22.5	22.0	21.7	6.2
G[400/560]	22.8 (21.6)	22.2 (21.8)	21.7 (21.3)	22.5 (19.7)	22.2 (14.0)	17.5 (9.6)	13.7 (8.5)	4.9 (3.0)
K[−1600]	9.4	10.9	10.8	5.7	3.7	2.7	2.2	1.5

*Figures in parentheses in this table are microscope analyses; the others chemical analyses.

Table III—Approximate Percentage Mineral Content, +8-Micron Material

Cell No.	1	2	3	4	5	8	14	25
Copper minerals	77	74	71	43	24	9	3	0.5
Pyrite	9	11	12	22	24	22	21	8
Molbydenite and sphalerite	3	3	3	4	5	4	3	1.5
Silicate	11	12	14	31	47	65	73	90

chanical tally recorder was used in addition whenever one mineral was very abundant.

From the frequency of occurrence of particles of the various minerals, and from the relative mass of particles of the various minerals, the mineralogical content and metal content of each product can be calculated. From the locked particles actually observed and through the use of correction factors to take care of the fact that locked particles may appear free,[5] the locking of the various minerals with gangue minerals and with other minerals can be calculated.

The mineralogical composition of the concentrate produced by the three cells is practically the same. However, the content of copper minerals in the sands (+ 1,600 mesh) decreases gradually from cell No. 1 to cell No. 3. Also, the pyrite and the silicate show small increases from cell No. 1 to cell No. 3.

The mineralogical composition of the middling varies much in going from cell No. 4 to cell No. 8, both in relative content of copper minerals to pyrite and silicates and in the nature of the copper-bearing minerals. The middling produced from cells No. 8 to 25 contains only a minor proportion of copper minerals. Generalized results are presented in Table III and part of the available detailed data in Tables IV and V. Fig. 3 is a graph corresponding to Table III. Fig. 4 is a graph presenting the relative abundance of the various copper-bearing minerals in the concentrate and in the middling. From these diagrams and tables, it is clear that chalcopyrite is the principal copper mineral, followed in order by covellite, gray copper, chalcocite, and bornite.

The relative sequence of flotation of the copper minerals is more difficult to ascertain, but from the greater abundance of chalcopyrite and bornite in the concentrate, as compared with the middling, one may assume that these minerals are the most readily floated

[5]Gaudin, "Flotation," p. 502.

Table IV—Size C (100/150 Mesh)

	Mineral Content, Per Cent							
Cell No.	1	2	3	4	5	8	14	25
Bornite	1.1	1.4	1.3	0.3	0.8	0.27	0.06	0.0
Chalcocite	2.8	2.8	3.2	2.6	2.0	1.81	1.07	0.15
Chalcopyrite	55.5	52.5	49.4	28.2	18.0	6.67	3.14	0.70
Covellite	7.9	8.2	7.6	4.5	2.7	1.59	0.98	0.15
Gray copper	6.0	5.5	5.7	4.1	3.7	1.46	0.64	0.05
Native copper	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0
Total copper minerals	73.3	70.4	67.2	39.7	22.2	11.80	5.90	1.05
Molybdenite	1.0	0.8	1.1	2.0	1.7	4.1	7.2	2.3
Pyrite	9.1	12.1	13.6	22.3	25.0	25.7	27.0	12.2
Sphalerite	2.0	1.5	1.5	1.2	0.8	0.5	....	....
Silicates	14.6	15.3	16.6	34.8	45.3	57.9	59.9	84.5

Table V—Size G (400/560 Mesh)

	Mineral Content, Per Cent							
Cell No.	1	2	3	4	5	8	14	25
Bornite	2.2	1.7	1.2	0.7	0.4	0.1	0.03	0.01
Chalcocite	4.4	4.2	3.3	1.9	2.0	0.5	0.09	0.05
Chalcopyrite	58.7	58.5	58.0	37.3	18.5	4.0	0.95	0.19
Covellite	5.1	7.7	9.5	4.7	2.3	0.9	0.15	0.01
Gray copper	10.2	9.6	9.0	6.8	6.2	0.6	0.78	0.07
Total copper minerals	80.6	81.7	81.0	51.5	29.4	6.1	2.0	0.3
Molybdenite	1.1	1.0	0.6	3.5	1.7	1.6	1.4	0.5
Pyrite	7.4	8.0	7.3	17.6	17.5	17.8	17.6	6.2
Sphalerite	3.1	2.1	1.7	1.7	0.9	0.8	0.4	0.9
Silicates	7.8	7.2	9.4	25.8	50.5	73.7	78.6	92.1

Fig. 3—Mineral content of froth portions coarser than 8 microns for froths of various cells

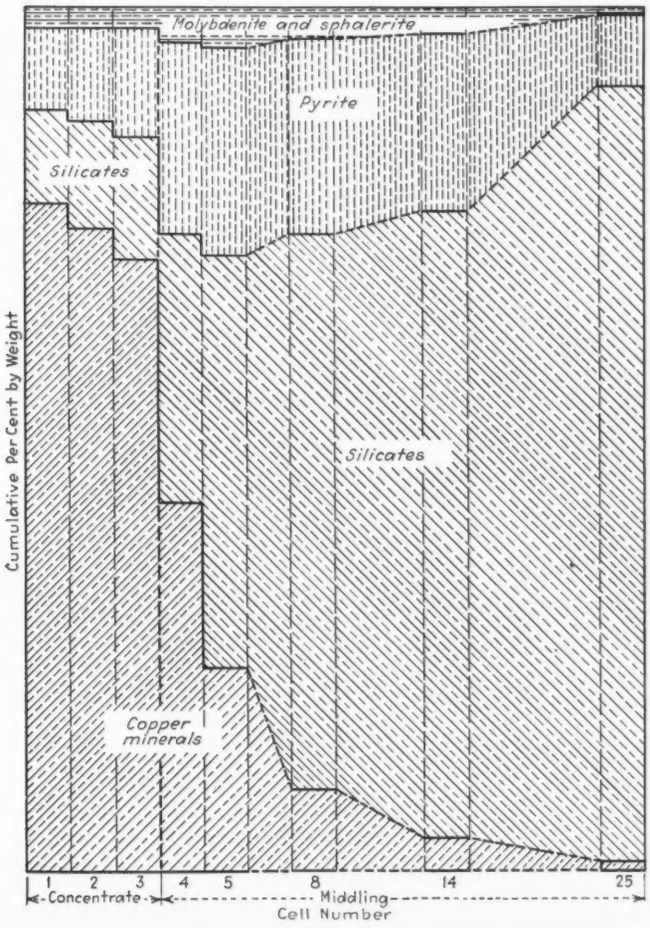
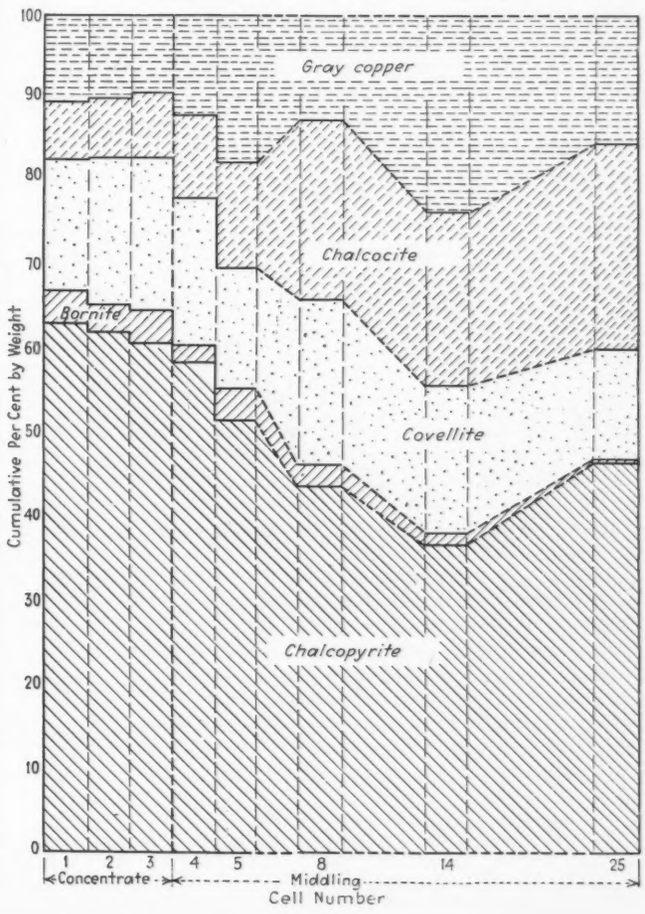


Fig. 4—Relative abundance of copper-bearing minerals in concentrate and middling



under the conditions prevailing when the samples were taken. Chalcocite and tetrahedrite appear to lag behind. The detailed sequence of flotation appears therefore to be:

1. Chalcopyrite and bornite
2. Covellite
3. Tetrahedrite and chalcocite

---

4. Sphalerite
5. Pyrite
6. Molybdenite

---

7. Silicates

In this connection one must recognize that the variations in the degree of locking of these various minerals with one another is such as to affect the sequence of their flotation, which must then be regarded as the joint effect of relative floatability under the prevailing conditions[6] and of the way in which the minerals are locked.

The term locked is used in this report to refer to particles composed of one or several copper-bearing minerals with one or several minerals barren of copper. Scientifically speaking, particles containing covellite with chalcopyrite, or pyrite with silicate, may be regarded as being locked, yet such an association cannot be regarded as of significance under present economic circumstances.

Liberation is, of course, the opposite of locking. In the concentrate the percentage liberation of the various minerals (by weight) is approximately as follows in the plus 20-micron portion which contains 79 per cent of the concentrate by weight and 84 per cent of its copper content:

Chalcopyrite	92	Sphalerite	62
Bornite	98	Pyrite	78
Covellite	95	Molybdenite	92
Chalcocite	85	Silicate	39
Gray copper	87		

From this it appears that most but not all of the silicate in the concentrate is brought there by particles in which it is locked with copper minerals. On the contrary, much of the pyrite, molybdenite, and sphalerite is actually free. It appears also that the chalcopyrite, bornite, and covellite are definitely freer than the chalcocite and gray copper, which probably accounts in part for their more ready flotation.

In the middling the locking of the copper minerals increases from cell No. 4 to cell No. 25; likewise the locking of the gangue particles decreases from cell No. 4 to cell No. 25 (Table VI). This shows, as one would expect, that the free particles of copper minerals float first, the locked particles of copper minerals and gangue next, and the gangue particles last—that is, under the most active frothing conditions.

A detailed statement of the locking observed in some of the products examined under the microscope appears in Tables VII and VII. A critical study of these tables discloses many interesting relations.

[6]Flotation reagents consisted of ethyl xanthate, 0.08 lb.; Yarmor pine oil, 0.2 lb.; and lime, 5.0 lb. per ton. More recently the quantity of lime has been reduced with resulting decrease in copper loss in tailing. (Private communication.)

Table VI—Weighted Percentage Degree of Liberation of Various Minerals—Sizes A-G (+560 Mesh)

	Concentrate (Cells 1, 2 and 3)	Middling				
		Cell 4	Cell 5	Cell 8	Cell 14	Cell 25
Bornite	98	87	92	66	59	30
Chalcocite	85	76	72	67	47	36
Chalcopyrite	92	90	67	55	48	33
Covellite	95	86	82	79	52	20
Gray copper	87	85	69	38	56	28
Total copper minerals	91	87	76	57	54	27
Molybdenite	92	95	93	98	98	98
Pyrite	78	87	87	94	98	99
Sphalerite	62	71	72	82	90	..
Silicates	39	57	57	81	90	97

Table VII—Percentage Locked, Size C (100/150 Mesh)

	Cell No.							
	1	2	3	4	5	8	14	25
Bornite	3	0	0	16	8	23	63	..
Chalcocite	15	20	20	30	25	24	67	100
Chalcopyrite	9	9	6	11	31	66	64	100
Covellite	3	5	6	16	16	28	39	100
Gray copper	12	11	17	19	30	92	83	100
Weighted average, copper minerals	8	10	10	15	19	57	62	100
Molybdenite	8	18	9	8	9	3	7	1
Pyrite	18	22	15	15	8	9	5	2
Sphalerite	39	37	42	31	27	..	..	..
Silicates	65	62	57	51	52	37	22	6

Table VIII—Percentage Locked, Size G (400/560 Mesh)

	Cell No.							
	1	2	3	4	5	8	14	25
Bornite	2	0	0	3	6	45	30	100
Chalcocite	2	2	2	20	25	41	46	46
Chalcopyrite	4	4	5	11	17	28	46	51
Covellite	3	6	6	13	17	15	53	70
Gray copper	5	8	7	17	26	23	25	58
Weighted average, copper minerals	3	4	5	12	21	29	38	60
Molybdenite	17	12	10	1	3	1	0	3
Pyrite	49	38	43	14	13	3	1	1
Sphalerite	58	35	21	30	22	18	10	21
Silicates	60	56	63	27	15	1	3	1

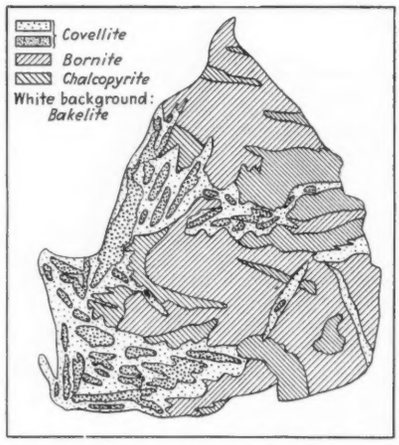


Fig. 5—Section of a particle containing locked copper sulphides, including covellite, chalcopyrite and bornite. Background is bakelite. X 1,000

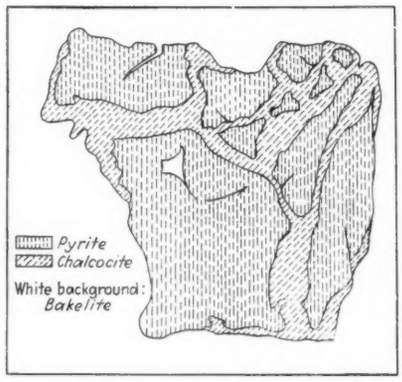


Fig. 6—Section of a particle containing pyrite and chalcocite. Background is bakelite. X 1,000

Mineral Associations

From the character of the particles appearing locked under the microscope, much can be learned of mineral associations:

1. Associations Involving Copper Sulphides Only—These are very common and of extreme beauty. Marvelous designs resulting from covellite needles penetrating smooth chalcopyrite areas, together with bornite, tetrahedrite, tennantite, luzonite, and chalcocite, are commonly seen. Fig. 5 shows one particle consisting of covellite, chalcopyrite, bornite, and covellite, approximately 60 microns in diameter.

Table IX presents the frequencies of occurrence of the various binary copper sulphide systems observed in the briquets of concentrate. Choosing arbitrarily the gray copper-chalcopyrite combination as reference (because both minerals are probably primary), one sees, for instance, that the occurrence of chalcopyrite-covellite particles is five times too common to be ascribed to mere chance. The significance of the figures is probably to be related to the genesis of the minerals. Mineral genesis is outside the scope of this paper, so that a discussion of the data presented in Table IX is omitted. Yet the possibility of drawing inferences having a bearing on the ore genesis from microscope

Table IX—Frequency of Occurrence in Concentrate of Particles Composed of Several Copper Sulphide Minerals

Type of Particle	Number of Particles Observed	Per Cent of Total	Relative Ratio*
Chalcopyrite-covellite....	1,019	60.2	5.0
Chalcopyrite-gray copper.	158	9.4	1.000[a]
Chalcopyrite-chalcocite..	154	9.1	1.5
Gray copper-covellite. ...	134	7.9	5.6
Covellite-chalcocite.....	94	5.6	6.2
Chalcopyrite-bornite.....	77	4.6	1.5
Gray copper-chalcocite ..	23	1.4	2.0
Bornite-chalcocite.....	15	0.9	4.1
Bornite-covellite.....	13	0.8	1.8
Bornite-gray copper.....	1	0.1	0.3
	1,688	100.0	

*Relative ratio of frequency of actual occurrence to that expectable from abundance of minerals in ore. The naturally expectable abundance of locked particles of a certain type is of course proportional to the product of the actual abundance of the two species in the ore.

[a] Chosen arbitrarily as reference point.

Table X—Frequency of Occurrence of Particles Composed of One Copper Mineral With One Other Mineral

Type of Particles	Number of Particles	Per Cent of Total	Estimated Relative Ratio*
Chalcopyrite-silicate.....	256	39.4	0.05
Chalcopyrite-pyrite.....	139	21.4	0.06
Chalcocite-pyrite.....	61	9.4	0.40
Gray copper-silicate	56	8.6	0.10
Chalcopyrite-sphalerite..	53	8.1	1.4
Covellite-pyrite.....	20	3.1	0.06
Gray copper-pyrite	17	2.6	0.07
Covellite-silicate.....	15	2.3	0.02
Chalcocite-silicate.....	11	1.7	0.03
Gray copper-sphalerite ..	11	1.7	2.4
Covellite-sphalerite.....	4	0.6	0.6
Molybdenite-chalcopyrite	2	0.3	0.05
Bornite-silicate.....	1	0.2	0.01
Bornite-pyrite.....	1	0.2	0.01
Molybdenite-covellite....	1	0.2	0.1
Chalcocite-sphalerite.....	1	0.2	0.3

*Estimated relative ratio of frequency of actual occurrence to that expectable from abundance of minerals in ore. Assuming ore to contain 15 per cent copper sulphides, 15 per cent pyrite, 65 per cent silicate, the same sphalerite to copper sulphide ratio as the concentrate and twice the molybdenite to copper sulphide ratio; calculated with respect to chalcopyrite-gray copper ratio of 1.000 (Table IX).

studies of mill products is worthy of attention.

2. Associations Involving Pyrite, Silicates, Sphalerite and Molybdenite With Copper Sulphides—These are also fairly common. Fig. 6 shows one particle of pyrite broken and cemented by chalcocite. The particle is approximately 50 microns in diameter.

Table X presents the frequencies of occurrence and estimated relative ratio of actual to naturally expectable occurrence. It appears that locked particles involving a copper mineral with a copper-free mineral are much scarcer than those involving two copper minerals, except the sphalerite-chalcopyrite and gray-copper-sphalerite combinations, whose relatively frequent occurrence is possibly related to an "exsolution" genesis of the minerals in question. Among the less rare locked particles are those of chalcocite-pyrite (probably because of secondary enrichment), covellite-sphalerite, and chalcocite-sphalerite. Among the particles involving silicates, those of gray-copper-silicate are relatively most abundant.

Table XI shows that most of the locked gray copper and chalcopyrite is associated with silicate, but that most of the locked chalcocite and covellite is associated with pyrite. It shows also that the particles locked with silicate lag behind those locked with pyrite. Accordingly, one might well expect the bulk of the losses to be in gray copper and chalcopyrite; also, one might expect the greatest relative tailing losses to be in gray copper. Since the silver is probably associated with gray copper, silver recovery is probably lower than copper recovery.

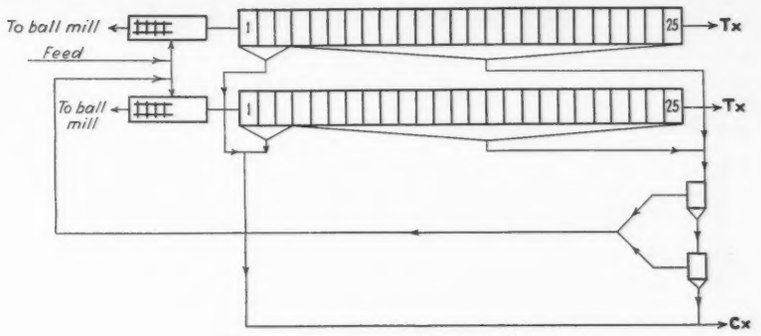


Fig. 7—Proposed flowsheet

Conclusions and Suggestions

Broadly speaking, the present investigation indicates the following:

1. The primary grinding appears to be sufficiently fine. This is shown by the high liberation of the copper minerals in the concentrate, and the relatively high mineralogical purity of the concentrate.

2. The roughing operation seems to be sufficiently extensive. This is demonstrated by the fact that about three-quarters of the copper, in particles over 20 microns in diameter occurring in the froth from the last cell, is locked with silicates, pyrite, sphalerite, or molybdenite.

3. The grade of the concentrate can probably be improved by cleaning. This is suggested by the fact that in the froth from the first three cells, four-tenths of the silicate and three-quarters of the pyrite in particles over 20 microns in diameter are free.

4. The froth from cells No. 4 to 8 can probably be improved structurally by grinding before returning to the head of the circuit. This, because about one-third of the copper and about as much of the gangue in particles over 20 microns in diameter occur as locked particles. Adoption of a regrinding operation at this stage would decrease considerably the circulating load, which is at present swelled by locked particles of intermediate floatability.

5. It would seem possible to improve the froth from cells No. 14 to 25 by cleaning before regrinding. About half of this froth consists of particles finer than 8 to 10 microns which have overflowed mechanically with the interbubble water. Stated in a different way, it may be noted that the ratio of material coarser than 10 microns to material finer than 10 microns is nearly ten times as great in the froth produced in cells No. 14-25 as it is in the froth produced in cells No. 1-3. Also, over 95 per cent of the plus 20-micron gangue in the froth from cells 14 to 25 is free and about two-thirds of the copper minerals in particles coarser than 20 microns are locked. This combination of circumstances suggests as desirable the following sequence of operations on the froth from cells 14 to 25: Cleaning, regrinding, recleaning.

6. Suggestions 2-4 are summarized in Fig. 7. This flowsheet is proposed as worthy of consideration in an experimental way. In addition to the requirements of the present flowsheet, the proposed flowsheet requires one ball mill, one bowl classifier, one flotation cell, several pumps, and perhaps a thickener.

It appears likely that a unit such as is suggested for consideration would (a) decrease the pyrite, molybdenite, and silicate content of the concentrate, (b) reduce the circulating load of locked particles, (c) increase the capacity of the unit, (d) decrease slightly the copper content of the tailing, (e) make the recovery of the molybdenite—in a separate flotation step—both easier and more complete.

Table XI—Percentage of Copper Locked With Silicate in Relation to Total Amount Locked

	Concentrate, Cells 1, 2, 3,				Middling Size C		
Mineral	Size A	Size C	Size E	Average	Cells 4 & 5	Cells 8	Cells 14 & 25
Chalcocite.....	6	14	26	15	42	59	76
Chalcopyrite.....	76	73	69	73	80	92	95
Covellite.....	0	17	43	20	29	74	68
Gray copper	89	84	100	91	95	100	100

BOOK REVIEWS

Faraday—Metallurgist

FARADAY AND HIS METALLURGICAL RESEARCHES. *By Sir Robert A. Hadfield, Bart. London: Chapman & Hall; pp. 329; illus.; 21s.*

The recent annual meeting of the Iron and Steel Institute at Sheffield, and the notable part paid by Sir Robert Hadfield in the scientific and metallurgical life of that important center of steel research and production, add especial interest to the treatise under review, on a subject a knowledge of which should form a groundwork of education for all who recognize the important part the addition of non-ferrous metals to iron has played in the establishment of the present industrial era. At this meeting Sir Robert, in his address of welcome, gave what in reality was an international review of this important phase of metallurgy, paying particular tribute to the achievement of British and American metallurgists, as well as to the metallurgists of note who have contributed and are contributing to scientific and industrial advance in Germany, France, Sweden, Italy, Japan, Holland, and Russia.

Faraday's contribution to the art of alloying iron with non-ferrous metals is inadequately recognized among those who are not specialists in the subject. Sir Robert's scholarly treatise is as helpful and as technically adequate as it is interesting in its wealth of historic detail. In addition to valuable material assembled on the nature of Faraday's research and contributions to the subject, the book recounts the important part played by the Royal Institution in sponsoring and fostering this research, for at its laboratory on Albemarle St., London, the first important investigations in this field were made by Faraday, whose name was then or later to be associated with those of Humphrey Davy, Tyndall, Dewar, and Bragg, all resident professors. Although the prestige of the Royal Institution was built upon the early work of Davy and Faraday, Sir Robert recounts that the society was founded, in 1800, by Sir Benjamin Thompson, also known as Count Rumford, who was born at North Woburn, Mass. At Harvard University he studied medicine and surgery and later served as professor of physics, held appointments under the Colonial Office, and spent eleven years at Munich. Honors included election to fellowship of the Royal Society and the American Academy of Arts and Sciences. As Sir Robert describes him, he was a citizen of the world. In establishing the Royal Institution he made possible the discoveries of Faraday and thus contributed to the foundation on which present-day knowledge of alloy steel is based.

In the work under review Sir Robert is supplementing his own notable contributions to metallurgical advance by the publication of a record of technical and historic fact, and by generously donating all royalties from its sale to the Royal Institution, in support of its work for the advancement of science.

Civilization and Economics

WORLD RESOURCES AND INDUSTRIES. *By Erich W. Zimmerman. Harper & Brothers, New York; pp. 842; $5.*

Primarily an economic study, this work has much broader implications; to quote from the author's foreword, its objective "is not to hand out bits of information of a vocational nature and of immediate use in the practice of some business or profession, but to promote a better understanding of our times, of our civilization and its problems." These specifications the book adequately fulfills. The first of the four parts, into which the work is divided, discusses the relativity and functional nature of resources; part two details the disastrous results on agriculture of industrial growth; modern mining and the major manufacturing industries are analyzed in part three; part four is devoted to the problems of conservation and of economic nationalism.

In discussing the copper industry in part three, reference is made, as follows, to the world copper cartel: "The passage of the new tariff law, the developments in Canada and Rhodesia, and the growth of European refining capacity, and many other factors have conspired practically to preclude the revival of the cartel along the same or even similar lines. It is doubtful whether the cartel would have proved successful even if the market crash had not come, for it represented an attempt to control the market price of a major commodity without a sufficiently firm hold on production. The cartel embraced a large enough share of the output and therefore was strong enough when measured in terms of geography and quantity of production; its weakness was qualitative and functional."

A forward-looking summary comprises the concluding section of the book, wherein is pointed out the importance of the fuller utilization of scrap metals in reducing the drain on the waning supply of virgin metals. Also, attention is directed to the fact that "one of the most effective conservation measures which man can apply is the avoidance of that catastrophe which, more than anything else, helps to drain the supply of resources without correspondingly advancing the compensatory arts and sciences—war."

In an age of uncertainty, in one of rapidly changing economic conditions, this book would seem well abreast of current underlying developments. That it will therefore be instrumental in providing the better understanding that the author advocates would seem assured. H. D. KEISER.

Map of the Earth

GEOLOGISCHE KARTE DER ERDE. *By Franz Beyschlag, with the assistance of the Prussian Geological Survey. Sections II and III. Verlag von Gebrüder Borntraeger, in Berlin. Price 240 Rm.*

This map, which is now complete, consists of three sections, each containing four map sheets, so constructed that the sheets when properly mounted may be used as a two-part wall map. Brief mention of Section I appeared in *Engineering and Mining Journal*, July, 1933. In addition to the twelve map sheets there are two extra sheets, briefly explanatory and containing time divisions and columns of formational units. The legends are printed in German, English, French, and Spanish.

Ocean depths are indicated by contours in meters and by varying delicate shades of blue, very perfectly registered. While the formational colors are brilliant, they are not displeasing; the colors present sharp contrasts, so that the areas representing different formations stand out clearly and may be readily distinguished from one another. Key letters are printed on the formation colors, or near them where the colored area is very small, so that no confusion should arise in cases where the same color is used for different formations.

The presswork is excellent throughout the entire series and the registration is perfect. The map is a fine piece of work, notwithstanding the necessary generalization owing to the small scale, 1:15,000,000.

R. J. COLONY.

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Report of the Gold Coast Colony Geological Survey Department, 1932-33. Gold Coast Colony. Pp. 30. Price 2s.

Azimuth Determination. By E. F. Coddington. Bulletin 79, Engineering Experiment Station, Ohio State University, Columbus, Ohio. Pp. 73. Price 50c.

Gemstones. Latest of a series on handbooks on the Mineral Industry of the British Empire and Foreign Countries. Imperial Institute, South Kensington, London, S.W. 7, England. Pp. 137. Price 2s. 6d. net, postage extra. Copies obtainable at H.M. Stationery Office, Westminster, London, S.W. 1.

Trends and Developments In the Industry

Senator Pittman Predicts Action On Silver by the President

Cables Authorities in India That the Metal Will Be Given Consideration Before Congress Meets in January and That Legislative Bodies Here Will Approve International Agreement

BRIGHTER DAYS for silver were forecast in the message cabled late last month to Sir George Schuster, finance member of the Indian Government, by Senator Key Pittman on the occasion of the ratification by the Indian Assembly of the international agreement for the rehabilitation of silver, which agreement was negotiated last July at the London Economic Conference largely through the efforts of Mr. Pittman. In his cable to Sir George, Mr. Pittman indicated his belief that President Roosevelt would aid silver. "We deeply appreciate India's action relative to silver agreement," he cabled. "The President has under consideration action before Congress meets. Congress will undoubtedly carry out agreement."

Following the dispatch of the cable Senator Pittman said that the Indian ratification of the agreement "shows great confidence in the United States and a whole-hearted desire to cooperate with our government in the restoration of the purchasing power of silver money.

"It removes all doubts that might have existed in any one's mind as to what other governments might do with regard to the agreement and it removes the possible threat of any dumping from India.

"Our government is obligated under the circumstances to carry out the agreement because it was proposed by the United States delegation on behalf and with the approval of the President.

"The President already had under consideration, prior to this announcement in India, action that would have complied with the agreement.

"I have no doubt that, having been granted the authority by Congress [to recognize silver] he will not wait for Congress to convene, but will act."

Countries whose delegates to the London Economic Conference signed the agreement last July were: Australia, Canada, United States, Mexico, Peru, India, Spain, and China. The agreement, subject to the ratification of the respective governments, provides that the three principal silver-holding countries—India, Spain, and China—will sell limited amounts of their silver stocks over a four-year period, beginning Jan. 1, 1934; whereas the five leading silver-producing countries—Australia, Canada, United States, Mexico, and Peru—will buy or withdraw from mine production a total of 35,000,000 oz. of silver yearly. This silver would be impounded in their respective treasuries to be used for currency purposes, either as coinage or currency reserves. The sales limitation allotments are: India, an average of 35,000,000 oz. yearly, but not more than 50,000,000 oz. in any year, or 140,000,000 oz. for the four years; Spain, 5,000,000 oz. yearly, or 20,000,000 oz. for the total period; China agrees not to sell any silver from demonetized coinage during the period. In brief, therefore, the five producing countries agree to absorb during the four years all but 20,000,000 oz., which would comprise the total amount that would then reach the open market from governmental sources. All the countries agree not to debase silver coinage below 800/1000's fine, and also to substitute, as far as possible, silver coins for paper currency of low denomination.

An additional provision of the agreement specifies that transfers of silver from India to the United States for war debt payments shall not be included in the limitation allotment, inasmuch as the United States Treasury's acceptance of the metal would be considered as an additional removal of silver from the market and as furthering the metal's monetary use.

A supplementary agreement allocates to each of the five producing countries the share of the 35,000,000 oz. of silver that it must absorb annually. United States is understood to have been allotted a major share of 24,000,000 oz. yearly. This allotment, on the basis of 50c. per ounce, would involve the purchase of $12,000,000 worth of silver from the mines of this country each year.

Under the terms of the agreement, ratifications by the several countries concerned must be deposited at Washington by April 1, 1934. The agreement provides for its own termination whenever India's allotted sales, plus the transfers of silver for war debt payments, shall reach 175,000,000 oz.

In his speech before the Indian Legislative Assembly on Nov. 21, when the agreement was ratified by that body, Sir George Schuster, according to an Associated Press dispatch from New Delhi, as published in the *New York Times*, said:

"We particularly hope this may help promote a good understanding with the United States.

"Americans interested in silver previously have been inclined to cherish rather bitter feelings against us on account of our policy of selling silver.

"They regarded this as a wrecking policy. All this was changed, I hope, by the London conversations, and I wish to testify as to my great appreciation for the attitude taken by Senator Pittman.

"If we are ready to cooperate we

Eavenson Nominated President of the Institute

Howard N. Eavenson, of Eavenson, Alford & Hicks, a vice-president and director of the American Institute of Mining and Metallurgical Engineers, was nominated for the presidency of the Institute at a meeting of the board of directors of the organization, held recently in New York. Albert Sauveur and Karl Eilers were made honorary members, and Pope Yeatman was nominated to receive the William Lawrence Saunders medal.

merely would be responding to the first move made on the other side.

"Senator Pittman supplied the initiative and devised a practical means of cooperation. I regard his success as the greatest achievement, for which he deserves the thanks not only of his own country but also of India."

Sir George contended that a silver pact would be in the interests of India, because it would give greater stability to the silver market in the next four years. He pointed out that India's currency had not been based on silver since 1893, so that the mere rise in prices would not increase the purchasing power.

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African Coppers Expanding Scale of Operations

Mufulira Copper Mines has started production on a small scale. A quantity of low-grade ore that had accumulated from earlier development is being put through the mill, and to this is being added the ore coming from current development work, which has been resumed in the upper levels. No stoping is yet in progress. Production, according to reports, will be worked up gradually, probably to the rate of 15,000 tons of copper annually, and, when demand justifies, to 20,000 tons. The work of unwatering the mine is proceeding rapidly, and resumption of development on all levels will probably be possible before the year ends.

Roan Antelope Copper Mines reports that a new technique developd by its smelter organization results in the almost complete removal of the very small amounts of impurities in Roan blister copper. The aim is to bring the smelter product up to the purity standard of electrolytic copper, as this would save to the company the difference in selling price now allowed for further fire refining. Roan is understood to be producing at the rate of 100,000,000 lb. of copper annually, or at about half its capacity.

The decision of Rhokana Corporation to erect an electrolytic refinery at its plant, at N'Kana, Northern Rhodesia, was prompted largely by the necessity of paying the refining charges on copper it was sending to America in dollars, then at a considerable premium over sterling. That disadvantage has now been removed, but erection of the refinery will proceed. Another reason was that by possessing an interest of more than 10 per cent in a refinery on this side of the Atlantic a contract with an American refinery would automatically be cancelled. When all these factors were taken into consideration, including the one of long delay occasioned by sending blister copper across the Atlantic twice before it could be sold, estimates indicated that a large saving in costs and interest would be effected by refining in Africa. The cobalt content of Rhokana ore is being converted into a source of revenue. About 40 tons of a 50-50 cobalt-copper alloy is being sold monthly, and arrangements are being made to refine this product also.

Rhokana Corporation is also making preparations to open a farther north shaft in its Mindola area. This is the extension of the N'Kana ore deposit. This shaft is understood to be merely for the purpose of extending the stoping and extraction area, and not necessarily to indicate an intention to increase production in the near future. The work of further developing the rich ore deposits in the N'Changa-West area is still being deferred.

Courtesy Roland Blanchard and H L. Downing

New Guinea bridge construction. An early stage in the erection of a native bridge on the Komiatum-Gadigadu route to the Bulolo goldfield. These bridges are made entirely of "kunda," a species of native cane that resembles bamboo

Development of Lead-Zinc Mines Proceeds in Yugoslavia

Development of the three lead-zinc properties in Yugoslavia, besides the Trepca mine, which are controlled by Selection Trust and Central Mining and Investment Corporation, is proceeding. The district in which these properties and Trepca are situated is interesting because the mines were worked extensively by the Romans, and by the Serbians in the Middle Ages, for lead and silver. Historical records show that Novo Brdo was one of the most important centers of Serbian industry, made so by the fame and productivity of the Kopaonik mining area surrounding it. The multitude of vast pits and caved shafts and adits are strongly confirmatory of this history.

Records indicate that the property owned by Novo Brdo Mines was for generations a large producer of silver. In one of the old workings the present company found ore containing 80 oz. of that metal to the ton. An adit being driven has entered a large gossan that contains 25 per cent of zinc. This adit will reach an area below extensive old workings.

In the Kopaonik Mines property, where an adit has been driven to cut the ore below the bottom of an ancient shaft and caved area, the work of determining the horizontal extent of the deposit is continuing. The body is evidently large, as workings are still being driven in ore. The area already proved is more than half as great as that of the Stantrg deposit mined by Trepca, and the geological conditions are strikingly similar.

Exceptional conditions prevail in this Serbian lead-zinc district, as in addition to the geology, easily traced among the steep hills, and the many and extensive old workings, the engineers have history to guide them in their research for commercial ores. The last previous mining activities ended about five centuries ago, so probably little other than the oxidized portions of the deposits were mined.

The policy of the interests that control the Zletovo, Kopaonik, and Novo Brdo mines in Yugoslavia is to employ the substantial funds now in hand for development work, and to make no public offering of shares of either of the three companies till sufficient ore reserves have been provided to justify the erection of a plant. The shares of these companies are not on the stock exchange and are not being quoted elsewhere.

Prospecting in Trepca's Meljenica area has recently revealed an interesting occurrence of ore which has not yet been fully explored. At present Trepca is extending its prospecting activities to other of the many known ore occurrences in its extensive area. It is drilling its Stantrg ore deposit, to determine its extent and grade below the deep adit level, but sinking the shaft below the adit may not be started until two years hence. Prior to that time no pumping will be necessary at the mine.

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Union Minière Adds to Reserves in Tchinsenda-Mokambo Area

A report is current that Union Minière du Haut-Katanga is continuing its explorations in the Tchinsenda-Mokambo area on the Northern Rhodesia frontier, where ore reserves are said to contain considerably more than 1,000,000 tons of copper. The exploration work referred to is being done by Société de Recherch Minière du Sud Katanga, a company formed last December to prospect for mines in Southern Katanga. Union Minière made over to this company certain of its rights in the southern area, together with the records of its exploration and development work, and acquired 16,-

125,000 francs of the new company's 46,000,000 francs capital, or nearly 40 per cent. A considerable tonnage of ore of most excellent grade, similar to the Northern Rhodesia ores, is known to have been proved in the Tchinsenda-Mokambo area, but the report that as much as 1,000,000 tons of copper has been disclosed by this exploration work cannot be confirmed.

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Conditions Improve in Norway

Baasmo Mines, Norway, following successful conclusion of negotiations with the Norwegian Government regarding underwriting the possible deficit for the year Sept. 1, 1933, to Aug. 31, 1934, has again started operations with a force of about 100 men. The mine, which produces a pyrite low in copper, has obtained an important contract for its product that will probably provide a profitable basis for its operations and make unnecessary the financial aid which was promised by the government.

Röros Copper Works, Norway's oldest copper producer, whose output, like that of most copper smelters, has been greatly curtailed during the last few years, recently increased the scale of its operations and is employing a force of about 300 men. This return of better times to Röros was celebrated by the declaration of a local holiday.

Courtesy Roland Blanchard and H. L. Downing

Completed "kunda" suspension bridge spanning the Watut River. No rope, steel, wire, or nails are used in the construction of these bridges. The "kanakas" (natives) shown here with caps, belts, and rifles are police boys. The surrounding tropical jungle is dense and impenetrable until a trail has been chopped through it. To discover and follow outcrops in such country is difficult, and such adverse conditions explain to some extent why Edie Creek and Bulolo gold fields were so long undiscovered

More Mines Reopen and Many New Plants Are Erected in Mexican Camps

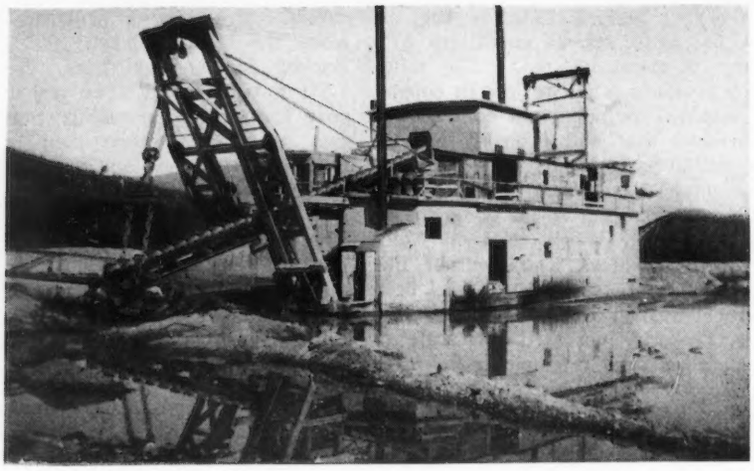
ENGINEERS of Sombrerete Mining are examining its mines in the Sombrerete region, Zacatecas State, with a view to conditioning them for an early resumption of work. General Eulalio Gutierrez, according to a recent announcement of the mines department of the Ministry of National Economy, plans soon to open up several mines in the Concepcion del Oro region of that state. . . . Potosi Mining and its metal-treatment subsidiary, Potosi Industrial, both operating in Chihuahua State, are reported to have increased their activities and restored salaries of their employees to pre-depression levels, because of improved conditions in world metal markets. The two companies are employing about 864 men. . . . Rio de Oro Gold Placer Mining has begun drilling 2,500 tests holes on 900 parcels of land that it controls near Loma Bonita, Oaxaca State.

A 30-ton flotation plant is being built by Cia. Minera del Monte, at the old San Miguel mine, near Taxco, Guerrero State, which property the company recently acquired and opened up after it had lain idle since 1911. Explorations show that the mine, which is being unwatered, can produce sufficient ore daily to keep the plant in steady operation. . . . A rich gold claim, known as Dolores Segunda, about 5 miles from the great Dolores mine, in Chihuahua State, is being worked by Manuel de J. Encinas, of Madera, Chihuahua. A shaft 86 ft. deep has been sunk on the property, and stringers of high-grade gold-silver ore have been disclosed. Crosscutting will be started when the shaft is down 100 ft. . . . Backed by George Law, American aviator, who conducts an aerial transport service in Chihuahua State, and two Mexican business men of Chihuahua City, development work has started on the Fairchild mine, near Potrero, Ocampo district, Chihuahua. The enterprise intends to establish a 25-ton mill and to open up the 200-ft. level of the mine, which is said to be rich in gold and silver ores.

American Smelting & Refining is arranging to increase activities in a short time at its mines near Charcas, San Luis Potosi State, and has invited all its former employees in the region to apply for work, according to official reports. . . . The management of the Peñoles Mining denies rumors that that enterprise proposes to buy out the Mexican interest of Mazapil Copper, declaring that it intends to concentrate efforts upon its own holdings. The statement adds that Peñoles Mining plans to intensify work at its Monterrey metal treatment plant, providing European metal prices continue satisfactory. The company exports on a large scale to many European countries, chiefly to France, Germany, and Italy.

A bismuth deposit, 1½ m. wide in its mine at Encarnacion, Jalisco State, has been found to warrant commercial exploitation, announces the Cia. Minera "Los Amigos," S.A., subsidiary of the "Los Amigos," Inc., of Wilmington, Del. The company claims to be the only metallic tin producer in America. A yield of 1.58 per cent metallic tin was obtained recently from 700 long tons of ore. . . . Operation of the La Soledad mine in the San Dimas district, Durango State, which was discovered in 1853, has been resumed by the Soledad y Anexas, S.A., which was recently reorganized with a capital of 150,000 pesos. The company has installed a 1,000-ton daily capacity mill, which was placed in operation about Oct. 15. The mill was started on a 50-ton daily basis, but the company hopes to have it at full capacity by the end of the year.

As the result of large orders for its gold and silver placed by American and European enterprises, Cia. Minera del Carmen has resumed operations in its Corazon de Jesus, Cocktelera, and Santa Rosa mines, in Zacatecas municipality, Zacatecas State. The company has engaged 100 additional miners and other employees for these works and proposes to further increase its working personnel. . . . Cia. Franco-Mexicana de Minerales, headquarters of which company are in Mexico City, has installed two large washing machines on gold-placer lands it controls near San Pablo Coutlan, Oaxaca State, and is shipping similar machinery to other of its placer fields along the Parian River, Oaxaca. The company expected to have all this machinery in operation



Dredge of the Idaho Gold Dredging Company operating in the Bitter Root Mountains near Warren, Idaho. An overburden of loam and sand is removed, prior to dredging, with a Le Tourneau Carry-All scraper drawn by a gasoline tractor

toward the end of November. . . . A discoverer's claim to the Mina de Marisanchez, a gold and silver mine near Guanajuato City that had a rich yield for years after it was opened in the middle of the eighteenth century by Miguel Aedo, a Spaniard, and which was abandoned about 1811, has been made to the Guanajuato City agency of the mines department of the Ministry of National Economy, and the British vice-consul there, by J. Norman Kourts, an Englishman, who has mined in the region for some time. He plans to organize a company for the operation of the old mine. . . . According to reports reaching Mexico City mining circles from Guaymas, Sonora State, an old gold mine near La Dura has been opened by Francisco Ortega and associates.

Guarichie Mining is installing a 50-ton daily capacity metal treatment plant costing $30,000 at its properties near Guarichie, Chihuahua State. . . . Professional and amateur gold seekers, Americans and Mexicans, from California and many parts of Mexico, have been attracted to rich placer gold fields found near San Antonio de la Huerta, Sonora State. Several hundred persons are working these deposits and earning from $1.50 to $10 a day each, according to reports. . . . El Potrero Mining, operating in Mocorito municipality, Sinaloa State, is now employing about 400 men, but announces that when machinery that it has ordered from the United States is installed its working personnel will be doubled. . . . Mexican Zinc has obtained a federal concession to establish a zinc refinery and sulphuric acid factory in San Juan de Sabinas municipality, near Saltillo, capital of Coahuila State, and to build a 14-mile network of canals to serve the plants, the total cost of these works to be 2,500,000 pesos (about $790,000 U.S.)

Fresnillo Mining proposes soon to resume working its Puerto Rico, Cinco Hermanos, and Sirena mines in the Concepcion del Oro zone, Zacatecas State, and is arranging with an electric light and power company for the installation of a 3,000-volt cable to convey power to the mines. . . . Operations have been started on gold-placer tracts covering about 6,250,000 square meters near El Palmar, Sinaloa State, by the Cia. de Placeres "El Palmar" y Bacubirito, subsidiary of Rio de Oro Placer Company, of Wilmington, Del. The company has invested about $30,000 in equipment and preliminary work at its El Palmar holdings, and is laying a narrow-gage railway three kilometers long, to transport gold-bearing ore to a washing plant. . . . About 70 tons of mining machinery, including a 2,000-yard shovel and a washing plant employing a Yuba riffle, has been placed in operation by California interests, headed by C. A. Barker, of Los Angeles, which has started work on 2,500 acres of gold lands in the Quitovac district, Sonora State, about 28 miles south of the American border. . . . American Smelting has taken over the Descubridora mine, near Chihuahua City, capital of Chihuahua State, which was operated by the late Alfred H. Kraf for several years, and progress intensive operations. . . . A five-year lease with a purchase option at the expiration of that term has been taken on the old Quitovac mine, Caborca municipality, Altar district, Sonora State, by A. E. Place, of Los Angeles, Calif., who expects to open the property early next spring. This mine was formerly owned by Charles Jackson, of Philadelphia, who operated it with a fifteen-stamp mill for about twelve years up to 1911, when the outbreak of Mexican revolutions forced a suspension of activities. Following Jackson's death, a few years ago, the mine was worked on a bootleg basis by prospectors.

Geological Association Formed at Princeton University

A new alumni organization, the Princeton Geological Association, was formed at Princeton University on Nov. 11, under the auspices of the advisory council of the Department of Geology. The new body will bring into more intimate relationship with the university a large group of departmental alumni, many of whom are engaged professionally in distant parts of this country and abroad.

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Vast Western Extension to Rand Freely Predicted

Within the last few months numerous "Far West Rand" companies have been floated, and the dominating organization in all this new development is West Witwatersrand Areas Company, formerly Western Rand Estates.

A year or two ago the Consolidated Gold Fields of South Africa secured an option over the properties of the Western Rand Estates and began a thorough scientific examination of the geology of the area. A further large block of farms lying to the east was acquired. Preliminary investigations were so encouraging that Consolidated Gold Fields, toward the end of last year, formed a subsidiary company, styled West Witwatersrand Areas, and began a well-planned and comprehensive program of boring.

A hole has penetrated to a depth of over 3,000 ft. on the farm Venterspost, adjoining Gemsbokfontein. Several other shot drills are in operation over a large area of ground, and an aërial survey has been carried out by means of which important data with regard to the general topography of the holdings and especially with regard to the presence of dikes and faults have been obtained. In general, indications of the persistence of the auriferous lower Witwatersrand beds have been so encouraging that many confidently expect that a vast potential western extension of the Rand will be proved definitely within the next few months.

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Canadian Kaolin Opens Plant At Lac Remi, Quebec

Canadian Kaolin Silica Products, a private company with N. A. Timmins, N. J. Emery, and N. A. Timmins, Jr., as principals, has opened its new 300-ton mill at Lac Remi, 90 miles northwest of Montreal, and is shipping its products regularly to plants in the Montreal district, with which contracts have been made. The silica and kaolin products were made first in a 75-ton pilot mill operated during 1932, the best mill practice thus being determined experimentally.

Higher Prices for Gold Stimulate Mining Throughout the United States

Expansion in Scale of Operations, Principally as the Result of Reconstruction Finance Corporation's Gold Quotations, Features the Reports Received From Many Mining Districts

MINING operations continued to expand during the past month, principally as a result of the advanced prices for newly mined gold as fixed by the Reconstruction Finance Corporation. Not all the new activity is in gold mining, however: Magma Copper announced that it will resume operations at its mine and smelter at Superior, Ariz., on Jan. 1; Anaconda Copper will soon start working the Mountain Consolidated and Stewart mines in Butte; Benguet Consolidated Mining is to develop chrome deposits in the Philippine Islands. A summary of the more important current mining operations in the various states is appended.

California

Idaho Maryland Mines will soon erect a new cyanide and flotation plant at its property near Grass Valley. The cyanide plant will process the tailing from the Idaho Maryland and Brunswick mines, and the flotation plant will treat the tailing dump west of the Idaho Gap Road.

Hoge Development, operating the Hoge mine, near Grass Valley, has let a contract to sink the main shaft from the 1,000-ft. level to a depth of 1,200 ft.

Operations are to be resumed at the old Cerro Gordo lead-silver mine near Owens Lake, according to Los Angeles reports. J. J. Beeson, of Salt Lake City, and Charles E. Trezona have acquired control of the property and adjacent claims by entering into an operating agreement with Cerro Gordo Mining and Estelle Mining. The Cerro Gordo mine has been an important producer of lead and silver for years and, until recently, was worked by American Smelting & Refining.

Atolia Mining, operating the Beebe, Alpine, and Eureka-Woodside mines, at Georgetown, has temporarily suspended milling operations at the Beebe mill to replace the old duplex Hadsel mill with two 200-ton single Hardinge-Hadsel mills of new design. It is also reported that A. D. Hadsel, inventor of the Hadsel mill, is said to have optioned the Ginacca mine, near Hornitos, Mariposa County, and to be erecting a Hadsel mill and a 50-ton cyanide plant. Another Hadsel mill is to be installed at the Big Blue mine, at Kernville, recently acquired by B. Baruch, of New York, and A. V. Udell and R. Long, of San Francisco.

Reconstruction of its No. 17 dredge has been undertaken by Yuba Consolidated Goldfields near Hammonton. The length of the hull will be increased from 165 to 225 ft., longer stacks provided, additional buckets installed, and the digging range increased to a depth of 120 ft. The remodeled dredge will work territory west of the old area, and is scheduled to go into commission early in 1934.

The McDonald dump at the North Star mine, Grass Valley, estimated to contain from 70,000 to 100,000 tons of tailing, has been leased by C. I. Cook, formerly with Nevada Consolidated Copper, and associates. Erection of a 100-ton treatment plant is planned.

Golden Center Mining, operating the Golden Center mine, at Grass Valley, is reopening the Black Bear mine, in the Rough and Ready district. Work is centered in rehabilitating the old shaft and construction of a surface plant. L. S. Wincapaw is general manager.

Reorganization work at the Yellow Aster mine, near Randsburg, operated by Anglo-American Mining, is proceeding satisfactorily. The 100-ton mill is being reconditioned, and flotation and cyanide units are being added to increase milling capacity to 250 tons. Mining operations will be conducted from the glory hole through a system of drifts, crosscuts, and raises. W. Val de Camp, former general manager of United Verde Copper, is in charge of operations.

Central Tailings Company, managed by Hamilton, Beauchamp & Woodworth, of San Francisco, has completed and placed in operation the new 600-ton cyanide treating plant near Sutter Creek, according to reports from Jackson, Calif. The plant is a replica of the Amador Metals Reduction plant at Jackson, and was built to re-treat tailing from the Central-Eureka mill.

Discovery of a substantial orebody on the 8,600-ft. level of the North Star mine, at Grass Valley, has been confirmed by the management of Empire-Star Mines. The vein was encountered in the course of explorative work recently undertaken by the company.

Operations have been resumed at the Grass Valley Premier mine, in the Newtown district, Grass Valley, following a brief shutdown caused by a heavy flow of water. The shaft has been unwatered, and sinking operations are to continue until a depth of 300 ft. is reached. Installation of a diesel power plant at a later date is planned. E. H. McMurrey is in charge of operations.

Control of the Keystone and South Spring Hill mines, near Amador City, has been acquired by the Snyder interests, of Salt Lake City, Utah, according to reports from Jackson, Calif. Rehabilitation work has begun at the Keystone, where old structures are being razed preliminary to erection of modern mining machinery and plant buildings. The South Spring Hill group has a recorded production of about $8,000,000 and is believed to contain the southeast extension of the Keystone vein system.

You Bet Mining is equipping the You Bet placers east of Grass Valley for large-scale production. A power line was completed recently, and larger flumes and additional machinery are being built and erected. About 60 men are employed.

The old Lost Emigrant gold mine, between Soda Springs and Robertson's Flat, is again producing after a long period of idleness. According to Harry Ramsey, 100 tons of ore are milled weekly and preparations for the installation of a 100-ton leaching plant are now under way. The company is also preparing for comprehensive work at the Carlisle group of gold claims, near Emigrant Gap. The Lost Emigrant is developed to a depth of 500 ft. and is said to contain a good grade of milling ore.

Sixteen-to-One Extension Gold Mines has acquired the Hallock-Hawkins gold mine, at Allegheny, adjoining the Sixteen-to-One mine. Comprehensive development and equipment of the property are scheduled to be completed before winter. The Hallock-Hawkins mine embraces three claims and is said to contain extensions of veins developed in neighboring properties.

Nevada

Advances in the price of gold have spurred most operators in Nevada to work their milling plants at maximum capacity, and a number of small mines and prospects have increased shipments to smelters. At the Round Mountain mill, which was formerly treating 200 tons a day, a substantially larger tonnage is being handled. At Manhattan, neighboring camp lessees in the White

World Production of Gold

(*American Bureau of Metal Statistics*)

In Fine Ounces

1933	August	September	October
United States (*a*)	181,000	271,000	252,000
Canada	257,000	236,000	245,000
Mexico	58,000	40,000	(*f*) 50,000
Colombia	38,000	27,000	(*f*) 30,000
Other South America	42,000	44,000	45,000
British India (*e*)	28,000	28,000	27,000
Japan (*e*)	35,000	36,000	35,000
Queensland	8,000	9,000	(*f*) 9,000
Western Australia	56,000	59,000	55,000
Other Australasia (*b*)	36,000	36,000	37,000
South Africa	931,000	902,000	909,000
Belgian Congo	22,000	21,000	20,000
Rhodesia	56,000	57,000	57,000
British West Africa	30,000	31,000	30,000
Russia (*c*)	(*f*) 160,000	(*f*) 160,000	(*f*) 160,000
Elsewhere (*d*)	(*f*) 80,000	(*f*) 85,000	(*f*) 90,000
Totals	2,018,000	2,042,000	2,051,000

(*a*) Includes Philippines. (*b*) Includes New Zealand and New Guinea. (*c*) Chiefly Siberia; 1933 estimated at average rate of 1932. (*d*) Includes West Indies, Central America, Europe, and Asiatic and African lands not separately reported; estimated. (*e*) Principal mines; nearly complete. (*f*) Conjectural.

Caps mine are shipping 200 to 250 tons of gold ore weekly to a Utah smelter. Two leases in the old Mary mine, at Silver Peak, are milling 40 tons daily and are shipping a better grade to Utah smelters. . . . A 75-ton cyanide mill at Gold Circle is running on high-grade gold-silver ore, and small mills in other camps add their quota of bullion. . . . On the Comstock lode, at Virginia City, Gold Hill, and Silver City, six mills with a combined capacity of 350 tons are operating on three shifts. A cyanide mill of 150 tons is being built at the Dayton mine, which should be operating by March 1, 1934. . . . Copper Canyon, operated on the leasing system, is producing 200 to 250 tons of gold ore monthly. . . . Placer mines are getting under way in Lyon County, and should be sending gold to the mint at San Francisco soon. . . . A lease at Goldfield shipped a car of high-grade ore from the Florence mine. Similar ore is also being shipped from the Tonopah Divide mine, 6 miles from Tonopah.

Goldfield Consolidated has acquired an interest with Tonopah-Halifax in an option on the Buckskin National mine, 67 miles north of Winnemucca, Nev. The mine is a noted producer of gold-silver ore of high grade and has a large tonnage of mill-grade ore developed. E. A. Julian, general manager of Goldfield Consolidated, is sampling developed ore, and R. A. Hardy, advisory engineer for Tonopah Halifax, is developing the Bucksin vein on the 400- and 800-ft. levels.

Dayton Consolidated Mines is installing a 150-ton cyanide mill at the Dayton mine, Silver City, Nev. The company purchased the Flowery mill near Virginia City, and is completing grading and foundation work. Ore will be transported 500 ft. from the Dayton shaft by electric locomotive over a surface tramway. The fine-grinding unit consists of ball mill and tube mill, each operating in closed circuit with classifiers. An electric hoist has been installed at the 900-ft. vertical shaft. George Fuerman is general superintendent. The mine, inactive since 1877 until unwatered recently, is on the southerly end of the Silver City branch of the Comstock lode.

The recovery mill, at Silver City, formerly a custom mill, has been taken over by South Comstock Mines, and is operating entirely on company ore. Ore is crushed in a battery of ten stamps operated by water power and passes to two amalgamating tables, thence to six K&K flotation cells. . . . The Donovan amalgamating and cyaniding mill, which formerly milled custom ore, is running on ore from the Silver Hill mine and other small properties. . . . Two flotation mills of 60 and 130 tons' capacity, respectively, are being operated by Consolidated Chollar, at Gold Hill, and the Arizona-Comstock, at Virginia City.

Utah

Alta Champion Mining is developing a promising body of ore, containing copper, gold, silver, and bismuth, from the Dwyer tunnel, in the Alta property. Three other leads are being followed from the same heading. The orebody in the southwestern portion of the property has been followed for 50 ft. in a raise and for 30 ft. on its strike.

The premium being paid for gold is stimulating production at the Eureka Standard mine in the Tintic, Utah, district, inasmuch as a much lower grade of ore can be shipped than before. . . . Zuma Mining has resumed operations at its property near Eureka. Cleaning out of the shaft has reached the 1,200 level.

Park City Consolidated Mines, under the direction of J. J. Beeson, general manager, is cleaning out its property near Park City preparatory to a resumption of shipments if the price of silver holds at a satisfactory level.

The Monarch mine, in the Lakeside district, near Salt Lake City, has been reopened by George H. Short, Salt Lake City engineer. Lead ore will be shipped to the Midvale smelter of the U. S. Smelting, Refining & Mining. At Gold Hill, Mr. Short is planning to sink the 180-ft. shaft in the Aurum Gold property to a depth of 380 ft. and to undertake 1,000 ft. of development work. A new pump has been installed and a new motor for the air compressor.

Development has been started by Engineers' Exploration & Mining in the Detroit district, 35 miles southwest of Delta, Utah, in the Utah Central Mines property. E. A. Boadway is in charge. The Copperhead shaft is to be enlarged to a two-compartment shaft and sunk from its present depth of 160 ft. to 1,000 ft., to explore fissures carrying gold, copper and silver.

The first shipment of gold ore was recently made from the Raft River property of Little May Mining, in northwestern Utah.

Sacramento Gold and Quicksilver Mines, operating at Mercury, Utah, has installed a new mercury furnace, which is treating about 30 tons daily. Small shipments of gold ore are being hauled by truck from time to time from the mine to the Manning mill, about 5 miles distant.

Operations have been resumed by Andrew L. Hurley and associates at the American Flag property in Park City, Utah, where the mine plant and old workings have been overhauled to permit starting work on the 1,150 level.

Manning Gold Mines Company, controlled by W. F. Snyder & Sons, Salt Lake City, Utah, and S. S. Arentz, former U. S. Representative from Nevada, has completed and placed in operation its new 500-ton cyanide plant at Manning, Utah. The plant was built to treat tailing from the old dumps in the district, and represents an expenditure of about $100,000. A total of 500,000 tons of tailing is available for treatment. A gasoline shovel and two trucks are employed to load and haul the material to the mill bin, whence it is fed by a 16-in. belt conveyor to a Hardinge ball mill operating in closed circuit with a Dorr classifier. The classifier overflow passes to two additional classifiers, the sands going to the waste dump and the slimes to the cyanide treatment plant proper employing the counter-current decantation process. Equipment contained in the mill was furnished by the Eastern Iron & Metals Company, of Salt Lake City, Utah. A total of 51 men are employed at the plant.

The Cardiff mine is producing 12 tons of ore daily from a new orebody on the 550-ft. level of the Big Cottonwood property, 25 miles from Salt Lake City. Part of the product is shipped to Coffeyville, Mo., and the remainder to a Salt Lake smelter.

Superior Gold Mines is erecting a 50-ton gold flotation mill at its property near Modena, Utah. Operations are under the direction of George Frawley, Salt Lake City, Utah, president of the company.

The higher price of gold has stimulated a resumption of operations of the property of Tintic Gold Mining, near Mammoth, Utah. Formerly known as the Emerald, the company has been reorganized as Tintic Gold, and installation of new electrically driven machinery completed.

Arizona

Magma Copper expects to resume normal operation of its mine and smelter at Superior, Ariz., about Jan. 1, according to a statement by Charles F. Ayer, president of the company. The decision to resume was made as a result of improving business conditions and an evident expansion in the use of copper.

The number of precious-metal properties in operation in Arizona continues to increase. At the Gold Coin mine of Southwestern Gold Mining, 6 miles east of Dewey, the shaft has been deepened from the 77-ft. level to 100 ft., where drifting will be started for a connection with old workings. The vein, which was 18 in. wide at the old shaft bottom, has spread out to cover the full width of the shaft. A number of camp buildings have been constructed, a larger hoist is to be installed, and pumps and compressor are being reconditioned. At the Grand Central mine, near Tombstone, leasers John Sebring and Jesse Hayward are building a 40-ton cyanide mill.

Some high-grade gold ore is reported to have been found at the Mount Aztec Gold Company property, 5 miles from Prescott on the Senator highway. Forty men are working at the mine on a co-operative basis. They receive board, lodging, mining supplies, and 50c. per day for their work. When gold is produced the company will receive one-third and the men will divide the other two-thirds or be paid standard wages

A new cyanide plant constructed recently by La Dicha Mining and Milling Company at Panuco, State of Coahuila, Mexico. Ore is ground to pass 40 mesh and then spread on cement floors to oxidize for several days prior to treatment with a 0.2 per cent cyanide solution

for each day they have worked. Robert Coyne, of Hollywood, Calif., is the owner of the mine and is sponsoring the project.

Mining in Mohave County is gaining impetus from the increased price for gold. At Oatman, the Big Jim and Telluride mines are producing steadily, and the Tom Reed is carrying on important development work. At the Oatman Rainbow property, near the Tom Reed, a 225-ft. shaft is being sunk on one shift and has reached a depth of 130 ft. At the Cyclopic, in the White Hills district north of Chloride, E. H. Crabtree has a 125-ton concentrator about ready to start. The Pilgrim gold property, just west of Chloride, is reported optioned to Texas interests. M. J. Hannon and Tom Frasier have secured a contract to sink a 500-ft. shaft at the Tin Cup in the Secret Pass section. A shaft is also to be sunk at the Black property on the Colorado River, 30 miles west of Kingman, and in the same area 35 men are working at the Roadside mine. In Yavapai County a new steel mill building has been erected under the supervision of H. B. Browning at the Monte Cristo. In the Steeplerock district, north of Duncan, Sullivan Machinery is doing some diamond drilling for Cactus Mining at the Jim Crow and Carlisle mines.

Deepening of the Junction shaft, at Lowell, by Phelps Dodge, which work was started in the latter part of August, is progressing satisfactorily. Steel sets, made of I-beams from the old Copper Queen smelter, are being used.

Montana

Anaconda Copper Mining has announced that it will soon start its Mountain Consolidated and Steward copper mines, in Butte, and shut down its Badger mine for reconditioning. Production of copper will not be increased by this change. The company has also shut down two units of its zinc concentrator at Anaconda and one unit of its zinc refinery at Great Falls, owing to its inability to get an adequate supply of zinc concentrate, according to announcements made by Cornelius F. Kelley, president, and W. B. Daly, general manager of mines. When the zinc plants were reopened after the long shutdown, the company received a contract to handle 50,000 tons of zinc concentrate from a Utah producer. This has been exhausted. Both the Orphan Girl mine of the company and the Emma mine of its subsidiary, Butte Copper & Zinc, are producing zinc ores at capacity.

Basin, a hamlet of Jefferson County, Mont., has not among its inhabitants one idle man that wants to work. The foremost gold operation in that vicinity is that of Roy E. Miller, Inc., which is working the old Jib property and employing 60 men, under the direction of Mr. Miller and his consulting engineer, August Grunert, and mill superintendent I. O. Proctor. About 550 tons of old mill tailing is treated per day, which material is handled with mechanical shovels. One of the shovels is said to have scraped on "bedrock" a few days ago and uncovered a hidden vein that contained substantial quantities of free gold. The Miller company has unwatered the East Katie, or "White Elephant," property to the 200-ft. level and is shipping ore to the Washoe smelter.

Beyond the Jib property is Basin Goldfields, which, in October, shipped 113 oz. of gold in the form of crude ore. The third company to add to the activity of the Basin section is Basin Montana Tunnel, with its 2,000-acre property on Comstock Hill, 2 miles east of Basin. Twenty men are being employed at the Grey Eagle property of this company, drifting on the 500 level and sinking the shaft an additional 300 ft. A high-grade lead-silver-gold ore has been encountered in the eastern section of the 500 level. This ore is being stored in the bin for shipment. The company expects to build a concentrator in the spring.

Colorado

What is declared to be the richest gold strike made since the early days has been opened up 18 miles east of Mancos, Colo. The first ore has been shipped to U. S. Smelting, Refining & Mining, at Midvale, Utah. More than 150 miles of trucking are necessary to get the ore to the railroad—85 miles westward to Monticello and thence through Moab to Thompsons, Utah.

At first thought to be a flash in the pan, engineers state that the camp has the earmarks of becoming an important gold producer. Hundreds of people are said to be visiting the area daily, and a new settlement has sprung up. From the standpoint of geology, the bonanza is said to be one of the most interesting ever discovered in the Intermountain region. Mineralization includes the occurrence of free gold in the LaPlata formation, along fissures. A tunnel has been driven 100 ft. on the vein, in which rich oreshoots occur at intervals. The find was made last October by Charles Starr, who is working the prospect with his five sons.

Minnesota

When the thermometer registered 15 deg. below zero early last month, the shipping season on the iron ranges closed with much ore to thaw out of the railroad cars before the boats could load it. All of the ore went forward, however, before Dec. 1, but the locks at the Soo will stay open until Dec. 15 for the late grain boats. The tonnage of ore shipped will total close to the 20 million predicted, and the operators feel that the tonnage to be shipped next year will exceed 30 million. This opinion is based on anticipated orders and the condition of stockpiles at Lower Lake ports.

With the demand for gold increasing, Minnesota hopes to enter the list of yellow-metal-producing states and be known as well for her bullion as for her iron-ore production. The best prospect at present is the property of Vermillion Gold Mines, 75 miles north of Hibbing and about halfway between Buyke and Crane Lake.

Philippine Islands

Benguet Consolidated Mining is to develop the chrome deposits of Florannie Mining in the Province of Camarines Sur, Luzon, P. I., according to an announcement by John W. Haussermann, president and general manager. The contract is profit-sharing and designed to utilize the technical and financial facilities of Benguet Consolidated for efficient and expeditious development of the properties in question. The chromite deposit was discovered in 1932, and so far about 50,000 tons of ore has been developed. Installation of machinery and additional development work will involve an expenditure of 250,000 pesos.

Codification of Non-Metallic Industries Proceeds at Washington

CODIFICATION of the non-metallic industries is proceeding steadily at Washington, with Assistant Deputy Administrator Ralph J. Fogg conducting most of the hearings. Codes that have been approved include those for the salt-producing industry, lime industry, and limestone industry. Hearings have been conducted on the codes for the feldspar, slate, mica, and talc and soapstone producing industries. Abstracts of the approved codes and of the hearings appear below. Codes submitted, but on which hearings had not yet been conducted on Dec. 1, included those for the fluorspar industry, national clay mining industry, asphaltic limestone industry, and the potash and borax industry.

A hearing on a proposed amendment to the code for the lime industry, presented by the Dolomitic Refractories Institute, was heard on Nov. 23. A summary of the hearing is appended.

Codes Approved

Salt—The code for the salt producing industry was approved on Sept. 7. Because of the different operating conditions in the industry in various parts of the country, wage and hour provisions are not as uniform as in most codes. Wage differentials provided for in the code for North and South, as well as for male and female workers, are not based on sex, race, or regional bases, but solely on the types of work performed and the varying costs of living. An outstanding feature of the code is the "child labor" provision, which states that no one under 21 years of age shall be permitted to work in the mines below ground. Hours are reduced from the prevailing 60- to 70-hour week. The seven-day week is eliminated.

Texas, Louisiana, and West Virginia were defined as the South in the code, and the minimum wage was set at 30c. an hour for male and 25c. an hour for female workers, whereas in the rest of the country, called the North, the minimum was set at 35c. for male and 32c. for female workers. Learners are to get 80 per cent of the minimum, and the amount thus paid is limited to 5 per cent of the total wages paid to all workers. Wage differentials existing prior to the code shall be maintained for all workers receiving $30 per week or less.

For processing or manufacturing operations, hours of labor set by the code shall not exceed a maximum of 42 in any one week, and for all other classes of workers, including miners, factory, office, and clerical employees, "an average during any six months' period of not to exceed 40 hours in any one week," is provided.

Lime—The code for the lime industry was approved Oct. 3. Under the provisions of the code no employee (except outside salesmen) shall work in excess of 8 hours in any one day or in excess of 40 hours in any week; provided, however, that these limitations shall not apply in periods of seasonal peak demand or in the event of lack of storage facilities, or emergencies, but in no event shall the total working hours of any employee, averaged over a six months' period, exceed 40 hours per week. All overtime work in excess of 8 hours per day shall be paid for at not less than one and one-half times the hourly rate. These maximum hours shall not apply to foremen, superintendents, managers, officials, or others compensated on a regular salary basis in excess of $35 per week.

The minimum rate of wages for employees, including accounting, clerical, and office employees, shall not be less than 30c. per hour in all territory south of the northern boundary of Virginia, Tennessee, Arkansas (including the manufacturing section known as Southwestern Missouri, Oklahoma, New Mexico, and Arizona, and in all other territory the minimum wage rate shall be not less than 37½c. per hour. There shall be an equitable readjustment of compensation now in excess of the minimum wages herein established.

The minimum rate of wages for accounting, clerical, or office employees shall be not less than $15 per week in any city of over 500,000, or in the immediate trade area of such city; $14.50 per week in any city of between 250,000 and 500,000 population, or in the immediate trade area of such city; $14 per week in any city of between 2,500 and 250,000 population, or in the immediate trade area of such city; and $12 per week in towns of less than 2,500 population. Population shall be determined by the 1930 Federal census.

Employees who by reason of old age or physical infirmities are incapable of normal productive effort may be compensated at a rate not less than 80 per cent of the foregoing minimum rates of pay, but the number of such employees shall not exceed 5 per cent of the total number of employees from time to time employed.

Employers shall not employ any person under the age of sixteen (16) years.

Each District Control Committee shall determine within its own district, and from time to time revise and promulgate for the guidance of the industry, the weighted average cost of each industry product manufactured in such district. Such cost shall be based upon the costs of individual manufacturers. In case of a district having no District Control Committee the manufacturers in such district shall report to the Trade Relations Committee, or its designated agency, necessary data to enable the Trade Relations Committee to determine weighted average costs for each industry product manufactured in such district, and the Trade Relations Committee shall determine such costs and promulgate the same for the guidance of the industry. Such average costs shall be subject to the approval of the Administrator and the substantiating data shall be open to his inspection at all times. Such determination of cost shall be made in such manner that individual figures are kept confidential and shall not be available to competitors.

After such average cost of each industry product is so determined for any district, no manufacturer in the industry shall sell any such industry product for delivery in such district at less than such average cost, plus basing rail freight. Any sale in any such district by any manufacturer at less than such average cost, plus basing rail freight, shall be an unfair method of competition.

Limestone—The code for the limestone industry, defined to mean the quarrying and/or fabricating of limestone for use as architectural building stone, was approved on Nov. 14 and became effective on Nov. 25. Minimum wages of 38c. an hour are specified, except in Alabama, Arizona, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, New Mexico, North Carolina, southern Ohio, Oklahoma, South Carolina, Tennessee, Texas, Virginia and West Virginia, where the minimum may be as low as the rate prevailing July 15, 1929, but in no event less than 30c. an hour. A maximum work week is to consist of 40 hours, averaged over three months, with the usual exception of professional, executive, supervisory, and sales employees.

The code creates a code authority, from one to three members of which are to be appointed by the Administrator. This code authority "shall determine with the approval of the Administrator a formula for arriving at the allowable cost for the various products of the industry, below which it shall be unfair practice to sell."

Summary of Code Hearings

Feldspar—Public hearing on a code of fair competition for the feldspar industry was conducted on Nov. 4 by Assistant Deputy Administrator Ralph J. Fogg.

A proposed code presented by W. N. Guthrie, secretary of the industry's code committee, establishes an average 40-hour week for the general run of employees, with the provision that repairmen, watchmen, engineers, and emergency maintenance employees may be worked 60 hours with overtime pay of one and one-third the regular rate for all hours in excess of 40.

Minimum hourly wages for employees in mining operations are fixed at 25c. in the South and 30c. in the North, those for tool dressers and drillers at 30c. in the South and 35c. in the North, and those for milling and grinding workers at 30c. in the South and 35c. in the North.

Clerical and office employees are to receive not less than $12 per week.

The proposed code provides that production, which is far in excess of the demand, be distributed equitably among members of the industry by the Code Authority until and unless a majority of the units in the industry vote to end this arrangement. A protest by any member against the quota assigned him is to be submitted to arbitration.

V. V. Kelsey, of the Consolidated Feldspar Corporation, Trenton, N. J., read a brief in support of the fair trade sections of the code.

The code committee submitted an amendment prohibiting the installation of new grinding equipment in the industry except with the approval of the Code Authority.

Slate—Wide divergence of opinion concerning maximum hours and minimum wages developed Nov. 9 between a spokesman for the American Federation of Labor and representatives of the slate industry at a hearing on the code of fair competition of the industry held in the Caucus Room of the New House Office Building. Assistant Deputy Administrator Ralph J. Fogg presided and sitting with him at the hearing were these advisers: Industrial, George Coffin; labor, John Tonkin, John Goshie; legal, Miss Bernice Lotwin; consumers,

S. F. Heinritz; and research and planning, Dr. Spencer Reed.

The code, as submitted by W. S. Hays, of Philadelphia, in behalf of the National Slate Association, provided a maximum work week of 40 hours, which could be extended to 48 hours in any one week during each six months' period beginning Aug. 1, and Feb. 1, with a provision for 12 hours a day in emergencies only. A minimum wage scale of $12 per week or 30c. per hour was also provided in the code as submitted, regardless of whether the employee is compensated on a time rate, piecework, or other basis.

Mr. Hays, in submitting the code in behalf of the National Slate Association, at the opening of the hearing, explained that his association was one hundred per cent behind the NRA. The slate industry, he said, is confined to certain regions in Maine, Vermont, New York, Pennsylvania, Maryland, and Virginia. He emphasized that it is absolutely necessary to set up fair marketing provisions, as proposed in the code, else the legitimate members of the industry will suffer from the competition of those who have not such heavy investments and who shirk all responsibility for fair dealing. He expressed the hope that the slate industry would be remembered with a share of the specifications under the Public Works Administration.

Mica—Objection of the National Electrical Manufacturing Association to being placed under the proposed code for the mica industry featured the code hearing held on Nov. 17, before Assistant Deputy Administrator Ralph J. Fogg.

M. A. Chapman, New York, representing the National Electrical Manufacturing Association, declared the electrical industry (which utilizes mica) is already under its own code (NEMI) and preferred to remain there. As president of two mica industries Mr. Chapman also objected to many of the provisions in the code under consideration, particularly the differential in minimum wages between North and South in the industry. The Labor Advisory Board objected to maximum hours as too long and to wages as too small.

Sitting with Assistant Deputy Administrator Fogg at the hearing were these advisers: Industrial, Bernard A. Brennan; labor, Dr. J. S. Gould; consumers, S. F. Heinritz, Dr. Emil Kekich; legal, Miss Bernice Lotwin; research and planning, John A. Hanley.

The code under consideration was submitted in behalf of the Mica Institute by Dr. E. E. Pratt, of New York, who explained its provisions and subsequently offered certain amendments. He said the code, as presented, represented the wet ground, dry ground, and sheet mica industries. The importers, he said, had given notice that they did not care to be included in the code.

As submitted by the Mica Institute, the code provided maximum average work hours of 40 a week averaged over periods of six months beginning Feb. 1 and Aug. 1 of each year, extended in certain circumstances to 54 hours a week. Minimum wages of 32c. an hour in the Northern area and 30c. an hour in the Southern area were proposed.

Dr. Pratt said foreign competition weighs heavily upon the sheet mica industry, particularly in the South. One of the greatest competitors is mica from India, where the price paid for labor is so low as to bear no comparison with American wages. He thought this phase of the question should be brought before the tariff authorities under NRA as soon as possible. He emphasized that the entire American mica industry is vitally affected by foreign competition.

Mr. Chapman, who objected in behalf of the National Electrical Manufacturing Association, on the ground that their members who are users of mica are now under the electrical industries code (NEMI), declared that no code should be granted to the raw or sheet mica industries. He said the organizations he represented would prefer to deal under the NEMI code.

Ralph J. Fogg

As an assistant deputy administrator in the NRA, Mr. Fogg, a consulting civil engineer and formerly head of the department of civil engineering at Lehigh University, is conducting hearings on codes for the nonmetallic industries. During the War he was in charge of construction at Camp Devens, and served as both resident and construction engineer at the Victory Destroyer Plant, Squantum, Mass. Prior to joining the faculty of Lehigh University in 1908, and following his graduation from Tufts College in 1906, Mr. Fogg was associated with the American Bridge Company and the New England Structural Company.

Mr. Chapman, as president of Eugene Munsell & Company and the Mica Insulator Company, of New York, also objected to many provisions of the code under consideration. He said 85 per cent of Munsell's mica sales was to the electrical industry. With respect to the code before the hearing Mr. Chapman said he was "not consulted, hadn't seen a copy of the code until two days ago, and never heard of the Mica Institute."

William Naumberg, Jr., New York, representing William Brand & Company, who declared that the code as submitted by the Mica Institute was not truly representative, drew from Dr. Pratt a rejoinder that it had been approved by 76 per cent of the sheet-mica industry.

Dr. Emil Kekich, for the Consumers' Advisory Board, proposed elimination of a provision, under competitive practices, which declared the necessity of charging prices that would insure a "reasonable profit." He moved that the word "reasonable" be stricken out. Another amendment would make revised price lists effective in five days or less, after filing, instead of ten.

Talc and Soapstone—A public hearing on a code of fair competition for the talc and soapstone industry was conducted on Nov. 21, by Assistant Deputy Administrator Ralph J. Fogg.

A proposed code for the industry was presented by Michael Doyle, president, and E. E. Magnis, code chairman, of the National Association of Talc and Soapstone Producers. It provides for a 48-hour work week for the general run of mine and mill employees, and establishes a minimum wage of 35c. per hour for men and 30c. for women, in the North, and 20c. an hour for men and 16c. for women, in the South.

The American Federation of Labor, through E. J. Tracy, demanded that the code be amended to provide for a 35-hour week, with a minimum wage of 50c. an hour for common labor, and $16 a week for office employees, with pay at the rate of time and one-half for overtime above 7 hours per day.

The testimony developed the fact that the industry is a sectional one, confined mostly to New England and New York State, the Carolinas and Georgia, and California, and Messrs. Magnis and Doyle explained that the terms of the proposed code, including the wage differential, had been agreed upon by the entire industry as being fair to the industry as a whole.

The West Coast division of the industry objected to the proposed wage differential and served notice, in a letter read by Mr. Magnis, that if the differential were retained the California producers would observe the code "only to the extent legally necessary" and would "take whatever recourse may be available" to dodge the wage minima.

Spokesmen for the Southern branch said the proposed wage was the highest they could pay and remain in business.

Miss Lucky Randolph Mason, of the National Consumers' League, asked that the code be amended to fix a 40-hour work week, to remove any discrimination in wages as between the sexes, and also to eliminate the proposed differential in pay between North and South. She said there was a recent instance in which 1,500 women replaced as many men in the automobile industry, because of the cheaper wage for women, and that "this undercutting of men by women is a serious problem in American industry."

Hearing on Code Amendment

Lime—A public hearing was conducted on Nov. 23 by Assistant Deputy Administrator Ralph J. Fogg, on a proposed amendment to the code for the lime industry, broadening that code to cover the manufacture of dolomitic lime sold as a refractory, and giving the dolomite branch its own code control.

The dolomite manufacturers are already under the code for the lime industry, as regards hours and wages.

The amendment was presented by Hugh Eels, President of the Basic Dolomite Company, of Cleveland, and head of the Dolomitic Refractories Institute. Other members of the industry present at the hearing were Daniel and Joseph Baker and Frank Thomas, of Baltimore; Benjamin Williams, of St. Louis; B. L. McNulty, of Chicago; S. W. Stauffer, of New York; and Bolton Corson, Plymouth Meeting, Pa.

Each individual dolomite manufacturer is to be a member of the divisional code control committee. It was said all but two had approved the amendment.

Personal Notes·Comment·Criticism

Arthur Notman has severed his connection with the NRA.

L. F. Hoag is visiting the Porcupine and other northern Ontario districts.

Edwin C. Eckel has been appointed geologist for the Tennessee Valley Authority.

Dr. W. L. Whitehead is examining properties in the Mother Lode mining district of California.

Eugene Rice, mining engineer of Miami, is in Colombia, South America, on professional business.

William Burns, of Duxbury, Mass., investigated gold prospects in Labrador during the past summer.

Leonard G. Smith is conducting the development of White Eagle Silver Mines at Great Bear Lake.

F. M. Passow has been appointed manager of Metals Development Ltd., at Narrow Lake, Ontario.

Horace G. Strong is developing the Halcrow Swayze gold property, in the Swayze area of Ontario.

Bernhard Day, engineer in charge of the operations of B. E. A. R. Mines, at Great Bear Lake, is on a visit to Europe.

Ernest Hibbert, consulting engineer for Noranda Mines and formerly general manager, has been appointed a director, in succession to the late Hon. H. H. Phippen.

Robert D. Ferron, mining engineer, has recently opened an office in Arequipa, Peru, for mine-examination and mine-operation work.

I. M. Marshall, formerly general manager of Central Manitoba Mines, has been appointed managing director of the Reno Gold Mines at Salmo, B. C.

G. A. Hellstrand has returned to the United States after eighteen months in Australia as consultant in mining operations to Mount Isa Mines, Ltd.

Charles A. Ordway recently examined a gold property at Winslow, Ariz., for the purpose of security issuance under the provisions of the Illinois security law.

Arthur Swanson, general manager of the Los Lugos Gold Mines, Mezquital del Oro, Zacetecas, Mexico, has returned to Mexico after a visit to San Francisco and Seattle.

Dr. Colin G. Fink, professor of electrochemistry at Columbia University, has been elected to receive the Perkin Medal of the Society of Chemical Industry for 1934.

Howard M. Propper, formerly with the Chile Exploration Company, has sailed from New York to join the staff of the Braden Copper Company at Rancagua, Chile.

F. R. Brooks, assistant mining superintendent at Roan Antelope, passed through London, Oct. 1, on his way back to the mine, following a vacation spent in Canada and the United States.

F. J. DeWilde, actively engaged in mining and engineering for the past twenty-five years, is now located at No. 11 South LaSalle St., Chicago, entering consultation practice, specializing in gold.

Horace G. Young has completed the examination of mining properties in the Alcona section of the Woman Lake, Summit Lake, and Red Lake areas of the district of Patricia, in northwestern Ontario.

W. P. Alderson, who has been conducting exploration operations in the Kenya gold field during the past year for a Montreal syndicate, has obtained from Canada a complete light mining equipment.

Nels Nelson, of Hibbing, Minn., has been appointed general superintendent of the Wisconsin Steel Company's mines. Mr. Nelson, formerly assistant general superintendent, succeeds W. B. Batchellor, recently deceased.

Arthur D. Storke, managing director of Roan Antelope. Rhodesian Selection Trust and Mufulira Copper Mines, has returned to London, following a prolonged visit of inspection to the properties in Northern Rhodesia.

J. Whitehouse, managing director of Trepca Mines, Novo Brdo, Kapaonik, and Zletovo mines, left London recently to visit the properties of these companies in Serbia, Yugoslavia. **J. A. Dunn,** E. M., accompanied him.

W. Val DeCamp, former general manager of the United Verde Copper Company, Jerome, Ariz., has been appointed general superintendent of the Yellow Aster mine, at Randsburg, Calif., controlled by the Anglo-American Corporation.

N. A. Veitch, formerly of N'Changa and N'Kana mines, is now assistant government metallurgist with offices in Salisbury, Southern Rhodesia. Mr. Veitch is assisting in the study of treatment for refractory ores, largely by the processes of flotation.

Frederick W. Foote recently made a joint investigation, with **A. K. Snelgrove,** for the government of Newfoundland into the rumored discovery of gold in Labrador. No commercial deposits were discovered. A typographical error caused Mr. Foote's name to appear in the October issue as "Forte."

Richard W. Smith, Assistant Geologist of Georgia for seven years, has been appointed Acting State Geologist by Governor Eugene Talmage, until the next meeting of the Forestry and Geological Commission of the State, which will select Mr. McCallie's successor.

Anson H. Smith, editor of the *Mohave County Miner,* of Kingman, Ariz., and **Mrs. Smith,** celebrated their golden wedding anniversary on Nov. 5 at a public reception in the rooms of the Kingman Elks Lodge, of which Mr. Smith is a Past Exalted Ruler and a life member.

G. R. Drysdale, who has been general auditor for the Phelps Dodge Corporation at Douglas, has been appointed comptroller of the corporation with headquarters at New York. **A. W. Engelder,** who has been Mr. Drysdale's assistant, will be in charge of Phelps Dodge auditing work in the West, with title of assistant general auditor.

Ira D. Travis, formerly vice-president of the Tintic Standard Mining Company, has been elected president to fill the vacancy caused by the death of E. J. Raddatz, and **James W. Wade,** has been advanced from the post of assistant general manager to general manager. **Harold E. Raddatz** will be treasurer, and **C. C. Henry,** director, to fill the vacancy on the board.

C. L. Palmer, of the Rio Tinto mines, in Spain, was a visitor in Canada during October. With **Balmer Neilly,** president, and **E. J. Carlyle,** secretary of the Canadian Institute of Mining & Metallurgy, he toured the principal mining camps of northern Ontario and Quebec, meeting the members of the Institute branches and telling them something of the operations and problems of the famous Spanish mines.

Dr. W. H. Collins, Director of the Geological Survey of Canada, initiated a special series of lectures at Northwestern University, at Evanston, Ill., on Nov. 21, 22, and 23. The series was made possible by funds raised by friends of the late Prof. U. S. Grant, to commemorate his distinguished services as a scientist and teacher. The subjects of Dr. Collins' lectures were: "The Economic Future of Northern Canada," "Major Correlation Problems of the Great Lakes Region," and "The Sudbury Mining Field."

James O. Greenan has resigned the general superintendency of Benguet Consolidated Mining Company, operating gold properties at Antamok, Benguet, Philippine Islands, to accept a position on the board of Marsman & Company, Inc., Stewart Building, Burnham Park Boulevard, Baguio, P. I. In association with **J. O. Enburg,** he will have direction of the company's mine consultation department, which will plan the further development of Itogon Mining, Suyoc Consolidated, the Paracale Corporation, Kilometer No. 73 Venture, Laguna Syndicate, and Nueva Ecija Placer Project. Marsman & Company will supervise purchases of equipment, mill plans, and extensions, and will act as general managers.

Ernest Wm. Ellis, author of the article entitled "Flotation on Mother Lode," which appeared in *Engineering and Mining Journal* for September, has written the Editor saying that his article, as published, should have read (on page 382), "Two and a half inch balls are added each shift," instead of "Two 5-in. balls are added each shift." In another place the article reads: "A large portion of the primary slime was roughed out by a Dorr thickener and sent to waste. Efforts were made to prevent loss of an appreciable amount of barren slime, because the smallest tonnage overflowing the thickener would assay from $2.50 to $3.50 a ton." Mr. Ellis says that obviously this is a contradiction, inasmuch as the idea was to waste barren slime, but that this proved impossible. The article at this point should have read: "An effort was made to waste barren slime by means of a Dorr thickener, but this proved impossible, since all slime carried value. Even with small tonnages of slime overflowing the thickener, the value of the slime would run from $2.50 to $3.00 per ton."

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"Composition of Copper Matte"

The Editor:

Twice I have written to Mr. C. K. Avetisian, author of the article on the composition of copper matte, published in *Engineering and Mining Journal* of December, 1932, and January, 1933, drawing his attention to the fact that I have been working on the same subject before and that the result of my studies described in *Metall und Erz*, 23 (1926), pp. 200-210, should be of interest to him.

As I did not obtain a reply I wish to bring this to your attention and shall be glad if you will publish the following notes regarding the conclusions drawn by Mr. Avetisian:

1. The final stable compound in copper matte is chiefly Cu_3FeS_3 (or written as $(Cu_2S)_3{\cdot}Fe_2S_3$). This compound corresponds to the mineral bornite (Buntkupferkies). The mineral bornite contains varying amounts of Cu_2S between $(Cu_2S)_5{\cdot}Fe_2S_3$ and $(Cu_2S)_2{\cdot}Fe_2S_3$ (Barnhardtite). Metallic copper is precipitated according to the formula:

$$4(Cu_2S)_2FeS = 2(Cu_2S)_3{\cdot}Fe_2S_3 + 4Cu$$

This composition corresponds to a copper content of 62 per cent Cu, and mattes of this composition show, therefore, a maximum content of metallic copper.

2. Matte with copper contents below 62 per cent contains chalcopyrite, $CuFeS_2$ (or written as $Cu_2S{\cdot}Fe_2S_3$), and further ferrous sulphide or magnetite, FeS + varying amounts of sulphur, besides the bornite.

3. Cooling of copper matte has always the effect that these compounds are formed. If the material is cooled very fast only the surface is obtained as $(Cu_2S)_2FeS$. The inner parts will always show the structure of the compounds higher in sulphur. The reaction starts at 548 deg. C. and is finished at 180 deg. C.

This explains the existence of metallic copper in Lake Superior and other copper ore deposits.

Further details can be seen from an article "Die Haarkupferbildung im Kupferstein," published in *Metall und Erz* 23 (1926), pp. 200-210. H. TIEDEMANN.
Berlin, Germany.

Prospectus Should Contain Reputable Engineer's Report

The Editor:

It is refreshing to read the editorial "Capital for Development of Gold Mines" in your September issue, commenting most lucidly upon the success of an English flotation of a gold property through a well-presented prospectus. Such commendable action may be effectively brought to more publicity in the United States through the recent Securities Act.

The average prospectus relative to the flotation of mining companies, in the United States, is a mass of confusing and inaccurate statements which readily mislead and enthuse the layman. There is generally no reference to essential data covering the commercial aspects of the mineralization, which can satisfy an experienced engineer that the proposition may have merit and be worth the gamble. As a rule the engineers associated with the flotation are unknown in mining circles, and also as members of engineering societies. To date the Securities Act has not insisted that mining prospectuses should be based upon reports of engineers known for their technical experience and ability who can be vouched for by an engineering society as to their high standard of ethics. The regulations governing issuance of securities, made public July 6, indicate the financial structure to the possible investors, but omit insistence as to reliable data relative to the commercial aspects of the business, which the investor is entitled to in the case of mining ventures through the publication of reports by engineers of prestige. It has recently been stated that President Roosevelt is determined as to "no relaxation of the present requirements for submitting full facts in regard to every security issue offered to the public"; yet the "full facts" demand, in the case of mining flotations, that reliable data through competent engineers' reports be presented. It would therefore seem apparent that the time is now opportune to set the public right in its desire to help mineral developments with the natural expectation of personal gain; a willing public deserves and should have a "run for its money," and not be inveigled to subscribe to shares of a worthless mining prospect or flotation. Mining exchanges might likewise take the foregoing indications under advisement and respond accordingly.

LESTER W. STRAUSS.
New York, N. Y.

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"Scrap and the Lead Market"

The Editor:

In the September issue of the *Engineering and Mining Journal*, an article appeared entitled "Scrap and the Lead Market," by Samuel Tzach, in the first paragraph of which was included the following sentence: "The situation has been strikingly pictured by one producer—St. Joseph Lead Company—in its statements that it is today the only producer of lead made solely from ore or virgin raw material." To the best of my knowledge and belief, we have never made such a statement, as it would be misleading and untrue. Our company does not buy or consume any secondary material, and all of our brands are made from virgin ore. On the other hand, the Bunker Hill & Sullivan Mining & Concentrating Company produces the Bunker Hill brand of pig lead at its smelter at Bradley, Idaho, which is also made solely from virgin raw material or ore, and there may be other smelters and refineries following the same practice.

IRWIN H. CORNELL,
Vice-president and sales manager,
St. Joseph Lead Company.
New York, N. Y.

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Then Along Came a Spider

The Editor:

I see in your September issue details of a "Novel Transit Repair." It is a useful tip, but by no means novel. I saw the same thing done by Professor Lovell at Camp Columbia in 1905 after a budding engineer had blown through the telescope tube with the idea of cleaning it. On this occasion the proceedings were enlivened by the escape of the spider up the professor's sleeve. Prompt action by the Class of '08 Mines saved the situation and the professor, and the repair was completed. I used the transit afterwards—the hairs were twisted. ROBERT ANNAN,
London, England. M.I.M.M.

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Gold Dredging in British Guiana

The Editor:

In a recent letter to the Editor (*E.&M.J.*, May, 1933, p. 210) I recommended British Guiana as an ideal place for the small gold-mining man. That letter has created some interest, and I hope some of the interested parties will come down here and see things for themselves. Although there is room and enough for the small man, this country offers opportunities for the big man in dredging. The gold area is large, and practically all the rivers that run through the gold belt have been proved to contain gold. No systematic testing of the rivers has been undertaken so far, and these rivers and creeks are nearly all open for location.

Only one small dredge (3 cu.ft.) is working in the colony at present, and although it is not fitted with the latest gold-saving machines, it is still paying well, if not handsomely. In some of the rivers the gold is very fine, but this can be caught by suitable concentrators.

Removing fallen trees which sometimes become buried is the most troublesome obstacle to be met, but proper arrangements on the dredge can remove them and place them on the banks, where the timbers can be cut and used as fuel. All the banks are wooded, so fuel is plentiful, but it would require motor transportation when cut at a distance from the river banks.

Interested parties should communicate with the Lands and Mines Department, Georgetown, which will supply all information required. A government geological party is now in the fields, and its findings are to be available on application.

To suitable and approved companies, the government extends very generous treatment in the way of concessions and exclusive permissions, which allow of prospecting being done thoroughly and without rush. *(Continued on next page.)*

The following figures from government sources may be of interest:

	Ounces	Ounces
Total production of gold from 1884 to 1932.....		2,714,834
Gold won by dredging since 1903	170,945	
Gold won by hydraulicking	38,367	209,312
Gold obtained from placer working		2,505,522

H. A. STEVENSON

Mackenzie, British Guiana

OBITUARY

Frank D. Carney, at Andover, Mass.; aged 68.

Andrew Sherwood, geologist, at Portland, Ore., on Oct. 31; aged 85.

Robert F. Frazier, retired mining engineer, at Philadelphia on Oct. 27; aged 84.

Charles R. Waters, mine superintendent for the Tom Reed Gold Mines, at Oatman, in Los Angeles on Oct. 25.

Robert G. Bear, treasurer of the United States Gypsum Company, at Evanston, Ill., aged 55.

Franklin W. Merritt, mine operator on the Cuyuna range in Minnesota, at Walker, Minn., on Oct. 18.

Dr. Edward Higginson Williams, formerly professor of mining engineering and geology at Lehigh University, at Westerdale, Vt., on Nov. 2; aged 83.

Dr. Oliver Cummings Farrington, curator of geology at the Field Museum of Natural History, in Chicago, since 1894; in Chicago on Nov. 2; aged 69.

George Hunt Barton, professor of geology at Harvard, expert on volcanoes, traveler, and writer; at Cambridge, Mass., on Nov. 25; aged 81.

Charles Butters, at Berkeley, Calif., on Nov. 27; aged 79. An appreciation of Mr. Butters' dramatic career will appear in the January issue.

Samuel W. McCallie, State Geologist of Georgia since 1908, at Atlanta on Oct. 26; aged 77. Mr. McCallie was a member of the Geological Society of America and the A.I.M.E.

Walter Butler, at Rochester, Minn., on Oct. 28; aged 75. Mr. Butler was chairman of the board of Butler Brothers, mining operators on the Mesabi range.

A. D. Miles, on Oct. 17, while a passenger on a Canadian Pacific train. Mr. Miles was president of Central Manitoba Mines and had long been identified with mining and industrial developments in eastern Canada.

Robert N. Richardson, mining engineer, at Boulder, Colo., on Oct. 13; aged 77. Mr. Richardson was a graduate of the Colorado School of Mines and one time superintendent of the Virginia mine, at Georgetown.

Samuel I. Silverman, mining man and charter member of the A.I.M.E., at Ely, Nev., on Nov. 21. Mr. Silverman was with John Hays Hammond in South Africa in the early days of that country's development, and more recently with the A. S. & R.

Archibald M. Chisholm, at Duluth, Minn., on Nov. 4; aged 69. Mr. Chisholm was treasurer of the Shattuck-Denn Mining Corporation at the time of his death, and was interested in many other mining properties as well. The city of Chisholm, Minn., was named after him, as was the Chisholm iron mine.

Edwin Higgins, managing director and secretary of the California Oil and Gas Association; on Oct. 23; aged 55. Mr. Higgins was assistant editor of *Engineering and Mining Journal* in 1908-1909, and later mining engineer with the United States Bureau of Mines.

Carl Clausen, well-known mechanical engineer of the Southwest, at Lowell, Ariz.; aged 71. Mr. Clausen received his professional training at technical schools in Germany and for 30 years before his retirement maintained engineering offices at Bisbee. He designed, installed, and superintended the operation of the first smelter at Cananea, Mexico, as well as numerous reduction plants the world over.

Charles Hays McMahan; in Huntington Park, Calif.; aged 63. After graduation from the School of Mines at Golden, Colo., in 1892, Mr. McMahan was employed at the smelter of the Guggenheims at Monterrey, Mexico. He retained professional association with the same interests until 1898. Later he was with A. S. & R. as chief engineer in charge of the exploration division of the company. Mr. McMahan moved to Long Beach, Calif., in 1897. He had long been a member of the A.I.M.E.

Russell Thayer, engineer and inventor, at Philadelphia, on Oct. 21; aged 80. Mr. Thayer had long been conspicuously identified with the industrial and civic life of Philadelphia and eastern Pennsylvania. He was the inventor of a gyroscope for the control of airships, and for many years latterly he had been engaged in the development of an electrochemical-centrifugal device for the commercial recovery of finely comminuted gold.

Emil John Raddatz, president and general manager of the Tintic Standard Mining Company, one of the outstanding and successful gold-silver-lead copper properties in the East Tintic district at Dividend, Utah, died at his Salt Lake home suddenly on Nov. 2 as the result of an attack of coronary thrombosis.

To Mr. Raddatz, who was 76 years old, goes the credit for bringing in the East Tintic mining district. Without his courage and faith, discovery of the mineral wealth of this area might have been delayed for years.

Born on Oct. 5, 1857, in Stettin, Germany, Mr. Raddatz came to Missouri in 1869, where he received further schooling to round out the education begun in his native land. In 1875, he went to Silver Cliff, Colo., where he engaged in mining. Eight years later, he went to Mexico, where he stayed for two years in the mining business. Returning to the Red Mountain district, Colorado, he remained there until 1887, when he came to Stockton, Utah. In 1890, he married Miss Emma Guth, of St. Louis.

While superintendent at the Honerine mine, Mr. Raddatz became interested in the East Tintic district, later taking over the group to be known as the Tintic Standard. For years, he stubbornly contended with the difficulties caused by limited financing, unknown geologic conditions, and heat and gas, until the Tintic Standard bonanza was struck. Then almost two years' delay ensued while another shaft, the present No. 2, was sunk to overcome the dangers of heat and gas. With the discovery of the Tintic Standard, a mining boom resulted in the East Tintic district, and other discoveries followed.

An Appreciation

Someone who knows the career but did not know the man should write the dramatic story of E. J. Raddatz in the history of Western mining. The career was rich in dramatic material, but the man never learned to dramatize himself, probably never thought of it, and those who knew him best would not undertake it.

He had his share of the excitements and hazards which attend long life in a profession that leads men to wild scenes and places, and unquestionably acquitted himself well amid them, but he mentioned them rarely and always for some purpose other than self-glorification. He embodied the iron determination, tremendous capacity, and genuine modesty that effects great achievements with almost complete subordination of the actuating personality.

He was so well poised, so wholesome of mind and spirit, so free from human vanity, that his later life was almost an anomaly. When great material success came to him after a struggle that lasted through long years and would have broken or distorted one less stalwart, his personal readjustments consisted of provisions to widen and enrich the lives of those about him. For himself he took nothing additional, except a little of the leisure he had formerly denied himself. He sought no honors, invited no adulation, courted no prominence, all of which he might have had, retained the old friends—and kept on prospecting.

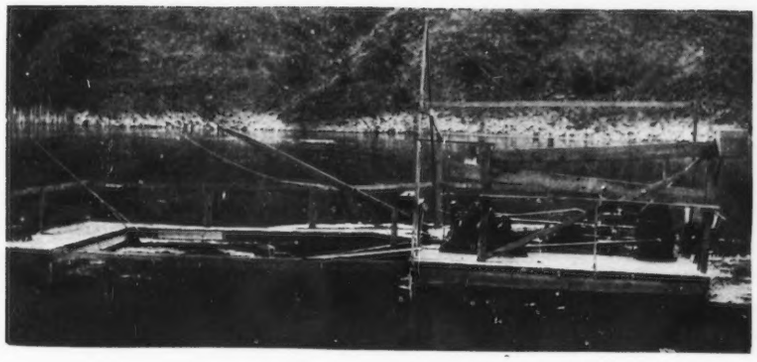
His course was in no sense due to eccentricity. He was wholly free from that; a normal, genial man, keenly interested in people and affairs, well informed, an agreeable companion, a dependable friend.

He was a true builder until the end, and gave freely of his abilities and resources for the development of many enterprises in his chosen region, without as well as within the industry in which he was best known.

He met life valiantly, calmly, and cheerfully, as unspoiled by its smiles as he was undaunted by its frowns.

A. G. Mackenzie.

INDUSTRIAL PROGRESS



Improved Suction Dredge

The illustration above shows a suction dredge which has been improved to enable it to work placer gold deposits on rocky river bottoms. This dredge, designed by the Production Engineering Company, Spokane, Wash., was made small so that it could be moved easily for exploring the extent and values of the bottoms. Some of the improvements are: a hydraulic self-cleaning nozzle that disintegrates the river bottom and feeds all undersize stones directly into the suction pipe, at the same time automatically ejecting the oversize. The latter is removed by a duplex stone rake. A riffle, equipped with means for amalgamation, is said to recover 98 per cent of the fine gold. A number of installations, ranging in capacity from 600 to 5,000 cu.yd., are being planned.

Special Dredge Pumps

For handling abrasive mixtures against high heads, the Morris Machine Works, Baldwinsville, N. Y., has designed a so-called Type F heavy-duty dredging pump. All parts subject to wear are of semi-steel, manganese steel, or special alloys. Casing and impeller are of large diameter, so that the pump will run at comparatively low speeds even when working against high heads.

Drifter Drill Auto-feed

An automatic feeding device for drifter drills which makes hand cranking unnecessary has been introduced by Ingersoll-Rand, New York. Besides freeing the operator from the need of constantly attending the drill, it is said to increase footage drilled. It is fully automatic, requiring no power and deriving its action from the natural tendency of a running drill to creep when the feed screw is allowed to turn in only one direction. This is made effective through a ratchet mechanism. In even ground after the hole is collared, the machine man, it is claimed, need pay no more attention to the drill until he has to change steel. The device is

Automatic feed for drifter drills, showing manner of reversing direction of feed

said to facilitate drilling in broken or fitchery ground. Other advantages are that it will pull tightly held steels that with hand cranking can be extracted only with difficulty. It will operate in close quarters, permitting the placing of edge holes where blasting will prove most effective.

Reverb Roof Life Trebled

A prominent copper plant, in smelting an unusually refractory charge, formerly obtained only 60 days' service from a complete silica brick arch and 90 days' from composite silica brick-magnesite construction using magnesite brick in the shoulders or wings and around the drop holes, according to the General Refractories Company, Philadelphia. In November, 1932, a complete magnesite arch 27 ft. long was installed, using a widely known brand of hydraulically pressed unburned magnesite brick and a popular method of suspension. The photograph reproduced on this page was taken Aug. 4, 1933, and shows the underside of the roof after 259 days of service. The furnace is back in use with no repairs to the magnesite arch, and several months' more life is confidently expected.

Underside of reverb roof after 259 days of service

A Rock Grab

A new device, which the manufacturer claims will make obsolete the customary dog and chain or sling methods for handling rock or cut stone, is a new rock grab developed by Bucyrus-Erie Company, South Milwaukee, Wis. With it rock may be tipped, rolled, or picked up, even when surrounded by other pieces. Similarly, it may be laid down exactly in place without resetting, shifting, or jacking. Releasing the closing line immediately frees the object lifted. So-called dog holes are unnecessary. The grab is turned out in 5-, 10-, and 20-ton capacity sizes.

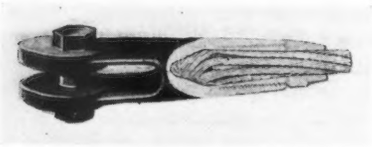
Controlling Sound Signals

Common use of sirens for outdoor signaling has brought about a growing demand for sound control, both by regulation of the sound signal itself, and regulation of the direction of the signal to affect only a specified area over which the sound should be heard. E. D. Bullard Company, San Francisco, has developed a dual sound-control applying to its Signal-Master sirens. A coding mechanism has been developed which gives a quick, sharp signal. This coding mechanism operates by means of a shut-

ter, which opens and closes the ports and intake area on the stator through which the sound travels. Up to 95 per cent of the sound can be held back by this device. Parabolic reflectors control the direction of the sound.

Improved Wire-Rope Socket

The accompanying sketch shows the design of a new and improved wire-rope socket, known as the "Fiege Tiger-



Improved wedge socket for wire ropes

Claw," which is produced by American Steel & Wire Company, Chicago. No zinc, babbitt, nor lead is required, or the use of flame in installing it. Its use is said to insure 100 per cent cable strength. It may be quickly attached in the field.

Another Rope Socket

A bulletin describing a so-called "No Pinch" type wedge socket, which is said to provide a highly efficient rope attachment specially designed to protect wire rope against abuse, has been issued by John A. Roebling's Sons Company, Trenton, N. J. These sockets, it is said, may be depended on to develop over 90 per cent of the ultimate rope strength. Design is such as to avoid all damage to the live or pulling end of the rope.

Shock Absorber for Wire Ropes

To avoid the premature weakening or destruction of haulage and hoisting ropes due to jerking and whipping, as when a skip or cage is loaded, Demag, of Duisburg, Germany, has brought out a device that absorbs and nullifies the shock of such jerks and whipping by means of springs and liquid damping. The apparatus is built in with intermediate tackle between the cage (or other equipment) and local connection or clamp. It is described in the "Demag News," published by the company, for September, 1933.

V-Rope Ratings Increased

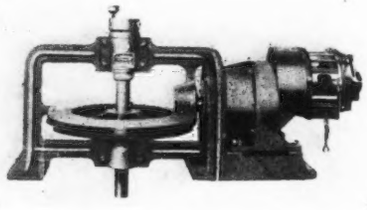
Texrope V-belt drives with one or both sheaves of the "Texsteel" type are now available in sizes ranging from ¼ to 15 hp., according to announcement by Allis-Chalmers. The sheaves are of grid-type construction, with accurately formed heavy gage steel sections electrically welded at web and rim. Outer rims are rolled for protection, good appearance, and strength. The sheaves are said to be well-balanced, light in weight, and practically indestructible.

Storage Battery Locomotive Redesigned

Radical improvements are said to have been made by Mancha Storage Battery Locomotive Company, 4850 South Halsted St., Chicago, in its Little Trammer locomotive, which the company introduced about eight years ago. The operator is given ample space and better protection against collisions. His compartment now folds up and stands vertically when the locomotive is being caged, in which position it can be placed by one man. Internal improvements have also been made which make the parts more accessible and provide a larger surface for those subject to wear. Provision has also been made for larger batteries.

All-Purpose Agitator

Used for several years with equipment made by the Patterson Foundry & Machine Company, the so-called Unipower agitator is now being made by the company as a separate agitator for



Agitator for all purposes

all purposes. It is built in both vertical and horizontal types, and when using 1,800-r.p.m. motors will produce shaft speeds down to less than 1 r.p.m. if desired, without use of gears. It is compact and light, according to the manufacturer, and one-way or two-way agitation can be accomplished without noise, vibration, or slop of any kind, and heavy, continuous loads or momentary overloads as high as 400 per cent can be carried.

Flotation Effects Visible

Use of clear glass in the flotation compartment of a new laboratory machine, introduced by Booth-Thompson Company, Salt Lake City, Utah, permits the operator to see what actually occurs with each reagent addition. The unit is known as the "Agitair." Smooth rounding corners and the glass surface allow no place for minerals to lodge. Froth overflow extends completely around the compartment. All metal parts within the shell are rubber-covered.

INDUSTRIAL NOTES

Lysaght Dominion Sheet Metal Corporation, Ltd., Hamilton, Ont., announces its introduction of Lydaloy galvanized sheets. These are being made in the Hamilton plant, which claims the honor of having been the first to make galvanized sheets in Canada, beginning in 1915.

Bulletins

Aluminum for Truck Bodies. Aluminum Company of America, Pittsburgh, Pa. Pp. 66. Accompanied by construction drawings and bills of material for the six types of bodies described, including a 2½-cu.yd. dump truck body.

Mining and Metallurgical Equipment. Demag A.G. Duisburg, Germany. Attractive in its illustrations, printing, and binding, this 200-page book describing Demag products and their applications must be seen to be appreciated. The plants and machines shown represent peak performances in the different lines concerned. A copy will be sent gratis to any seriously interested company.

Welding and Riveting Aluminum. Aluminum Company of America, Pittsburgh, Pa. Two pamphlets, one on "welding" and the other on "riveting." Pp. 42 and 26 respectively.

Compressors. Worthington Pump & Machinery Corporation, Harrison, N. J. Single horizontal-single stage air compressors, steam- and motor-driven. Pp. 8.

Jaw-Crusher. Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Blake and Dodge-type, standard and sectional. Pp. 12.

Liquid Oxygen. Superior Air Products Company, 132 Malvern St., Newark, N. J. Bulletin or liquid oxygen apparatus and containers.

Pipe. Taylor Forge & Pipe Works, Chicago, Ill. Catalog 33, on spiral pipe, riveted or welded. Pp. 62.

Screens. Mining & Industrial Equipment, Ltd., 11 Southampton, London, W.C. 1, England. Bulletin 61, Tyler screens. Pp. 16.

Wire Rope Attachment. John A. Roebling's Sons Co., Trenton, N. J. Bulletin on "No Pinch" type wedge socket. Pp. 8.

Haulage. Jeffrey Manufacturing Co., Columbus, Ohio, Catalog 555 on mine locomotives. Pp. 44.

Pumps. Morris Machine Works, Baldwinsville, N. Y. Bulletin 150 on double-suction, high-speed pumps. Pp. 8.

Thickening. General Engineering Co., Salt Lake City, Utah, Toronto and London. Bulletin, Geco settling tanks. Pp. 14.

Photoelectric Relays. General Electric Co., Schenectady, N. Y. Bulletin GEA-1654A on CR7505 photoelectric relays. Pp. 16.

Magnetic Separation. Magnetic Manufacturing Co., Milwaukee, Wis. Bulletin 100. Facilities of Stearns testing laboratory.

Acid-Proofing. Patterson Foundry & Machine Co., East Liverpool, Ohio. Pamphlet. Acid-proofing for old and new containers with Porox cement and blocks. Pp. 4.

Daily and Average Monthly Prices of Metals

November, 1933

United States Market

Nov.	Electrolytic Copper Domestic	Electrolytic Copper Export	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
1	7.775	7.525	48.950	4.30	4.15	4.70@4.75
2	7.775	7.625	49.700	4.30	4.15	4.65@4.70
3	7.775	7.625	49.750	4.30	4.15	4.50
4	7.775	7.625	49.850	4.30	4.15	4.50@4.65
6	7.775	7.625	49.950	4.30	4.15	4.50
7	Holiday	7.575	Holiday			
8	7.775	7.575	51.125	4.30	4.15	4.50
9	7.775	7.625	53.000	4.30	4.15	4.50
10	7.775@8.025	7.725	53.400	4.30	4.15	4.50
11	7.775@8.025	7.800	53.000	4.30	4.15	4.50
13	7.975@8.025	7.850	53.750	4.30	4.15	4.50
14	8.025	7.875	54.950	4.30	4.15	4.50
15	8.025	7.875	55.500	4.30	4.15	4.50
16	7.775@8.025	7.700	55.250	4.30	4.15	4.50
17	7.925@8.025	7.700	53.500	4.30	4.15	4.50
18	8.025	7.675	54.375	4.30	4.15	4.50
20	8.025	7.675	55.375	4.30	4.15	4.50
21	8.025	7.700	55.625	4.30	4.15	4.50
22	8.025	7.725	55.750	4.30	4.15	4.50
23	7.775@8.025	7.675	54.125	4.30	4.15	4.50
24	7.775@8.025	7.600	53.250	4.15@4.30	4.15	4.50
25	7.775	7.525	53.200	4.30	4.15	4.50
27	7.775	7.475	52.250	4.30	4.15	4.50
28	7.775	7.475	53.250	4.15@4.30	4.15	4.50
29	7.775	7.550	53.400	4.15	4.05	4.50
30	Holiday	7.425	Holiday			
Av. for month	7.881	7.647	53.011	4.288	4.146	4.520
Averages for Week						
1	7.858	7.583	48.675	4.300	4.150	4.746
8	7.775	7.608	50.075	4.300	4.150	4.550
15	7.938	7.792	53.933	4.300	4.150	4.500
22	7.996	7.696	54.979	4.300	4.150	4.500
29	7.817	7.550	53.246	4.250	4.133	4.500
Calendar Week Averages						
4	7.796	7.596	49.325	4.300	4.15	4.663
11	7.825	7.654	52.095	4.300	4.15	4.500
18	7.992	7.779	54.554	4.300	4.15	4.500
25	7.942	7.650	54.554	4.288	4.15	4.500

Silver, Gold, and Sterling Exchange New York and London

Nov.	Sterling Exchange "Checks"	Sterling Exchange "90-Day Demand"	Silver New York	Silver London	Gold London	Gold (a) United States
1	4.79000	4.82000	40.0000	18.3125	131s 9 d	$32.26
2	4.83000	4.87000	40.8750	18.5625	133s 3 d	32.36
3	4.84000	4.87000	40.5000	18.5000	133s 2 d	32.57
4	4.85750	4.88500	40.7500	18.5625	132s 4½d	32.67
6	4.88250	4.91250	41.5000	18.5000	131s 10 d	32.84
7	Holiday	Holiday	Holiday	18.6250	129s 11½d	32.84
8	4.95500	4.98500	41.8750	18.5000	131s 10 d	33.05
9	5.04000	5.07000	42.8750	18.5625	130s 11 d	33.15
10	5.12000	5.14000	42.7500	18.4375	129s 8 d	33.20
11	5.09250	5.12250	42.8750	18.3750	130s 1½d	33.32
13	5.13500	5.17500	43.7500	18.6250	129s 1½d	33.45
14	5.24000	5.27000	45.0000	18.5625	128s 7 d	33.56
15	5.36000	5.39000	44.7500	18.5000	129s ½d	33.56
16	5.49500	5.54000	45.0000	18.3125	128s 6 d	33.56
17	5.29500	5.34500	44.6250	18.3750	128s 2 d	33.56
18	5.25000	5.29000	43.3750	18.3125	128s 2 d	33.56
20	5.30500	5.35000	44.2500	18.3750	127s 7 d	33.66
21	5.37000	5.40000	44.5000	18.3750	127s 0 d	33.76
22	5.41000	5.45000	44.7500	18.3125	126s 6 d	33.76
23	5.32000	5.37000	43.3750	18.2500	125s 8 d	33.76
24	5.20000	5.24000	42.8750	18.4375	126s 1 d	33.76
25	5.18500	5.24000	42.7500	18.3750	126s 6 d	33.76
27	5.11000	5.15500	42.0000	18.3750	125s 3½d	33.76
28	5.20000	5.25000	43.0000	18.3125	125s 6 d	33.85
29	5.21500	5.26000	43.3750	18.3125	125s 6 d	33.93
30	Holiday	Holiday	Holiday	18.3750	125s 1½d	Holiday
Av. for month	5.14573	.....	42.974	18.428		.....
Averages for Week						
1	4.74854	.....	39.167	.....		.....
8	4.87300	.....	41.100	.....		.....
15	5.16458	.....	43.667	.....		.....
22	5.35417	.....	44.417	.....		.....
29	5.20500	.....	42.896	.....		.....

Calendar week averages: New York Silver Nov. 4, 40.188; Nov. 11, 42.375; Nov. 18, 44.417; Nov. 25, 43.750.

London Market

Nov.	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic Bid	Tin Spot	Tin 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
1.....	32.6875	32.8125	36.0000	224.3750	224.1250	11.6875	12.0625	15.5625	15.9375
2.....	32.5000	32.6250	36.0000	224.7500	224.3750	11.5000	11.8750	15.5625	15.9375
3.....	32.6250	32.7500	36.0000	224.8750	224.5000	12.0000	12.3125	15.6250	15.9375
6.....	32.0625	32.1875	35.5000	224.7500	224.2500	11.7500	12.1250	15.5000	15.8750
7.....	31.4375	31.5625	35.0000	224.7500	224.2500	11.7500	12.0000	15.4375	15.6875
8.....	31.8750	32.0000	35.0000	226.7500	226.2500	11.8750	12.1250	15.7500	15.9375
9.....	31.8125	31.8750	35.0000	230.0000	228.7500	12.0000	12.1875	15.8750	16.0625
10.....	31.6875	31.8750	35.0000	229.2500	228.3750	11.8750	12.0625	15.6875	15.9375
13.....	31.6875	31.8750	35.0000	229.8750	228.7500	11.6875	11.9375	15.2500	15.5625
14.....	31.2500	31.3750	34.5000	229.7500	228.7500	11.5000	11.7500	15.0000	15.3750
15.....	29.3750	29.5625	33.0000	226.7500	226.2500	11.0000	11.2500	14.5000	14.8750
16.....	28.7500	28.8750	32.0000	226.7500	226.3750	11.1250	11.3125	14.6250	15.0000
17.....	29.6250	29.8125	33.0000	226.6250	226.2500	11.4375	11.6250	15.0000	15.3125
20.....	29.2500	29.3750	32.5000	227.7500	227.6250	11.2500	11.4375	14.8125	15.1250
21.....	29.3125	29.5000	32.5000	227.7500	227.6250	11.1875	11.3750	14.5000	14.8750
22.....	29.3750	29.5000	32.5000	227.3750	227.3750	11.1875	11.4375	14.4375	14.8125
23.....	29.3125	29.4375	32.7500	227.0000	227.0000	11.3750	11.6250	14.3750	14.7500
24.....	29.3125	29.4375	32.7500	226.0000	226.0000	11.5000	11.6250	14.5000	14.6875
27.....	29.7500	29.8750	33.0000	226.0000	226.0000	11.5625	11.7500	14.6250	14.8750
28.....	30.1250	30.3125	33.5000	225.6250	225.6250	11.5625	11.8125	14.8750	15.1250
29.....	29.5625	29.7500	32.7500	225.5000	225.6250	11.5625	11.7500	14.7500	15.0000
30.....	29.5625	29.6875	32.5000	225.6250	225.7500	11.4375	11.6875	14.8125	15.0000
Av. for month.	30.588	.....	33.898	226.722	.....	11.537	11.778	15.048	15.349

The United States quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices of domestic class are in cents per pound.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted as 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West are based on a minimum

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1932	1933	1932	1933	1932	1933
January	29.780	25.400	19.623	16.883	342.515	336.060
February	30.136	26.074	19.573	16.885	345.141	342.114
March	29.810	27.928	18.336	17.588	363.463	343.138
April	28.298	30.730	16.923	18.440	374.731	357.565
May	27.755	34.072	16.868	19.046	367.370	393.106
June	27.466	35.663	16.844	19.078	364.471	413.216
July	26.700	37.630	16.930	18.341	354.865	464.760
August	27.986	36.074	18.000	17.877	347.449	449.944
September	27.870	38.440	17.998	18.272	347.003	466.240
October	27.195	38.190	17.813	18.221	339.500	466.380
November	26.698	42.974	18.099	18.428	327.458	514.573
December	25.010	.....	17.110	.....	327.683	.....
Year	27.892	.....	17.843	.....	350.137	.....

New York, quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery			London Spot			
	Electrolytic			Standard		Electrolytic	
	Domestic		Export				
	1932	1933	1933	1932	1933	1932	1933
January	7.060	4.775	4.741	39.459	28.557	46.200	33.244
February	5.965	4.775	4.710	36.917	28.481	41.381	32.556
March	5.763	5.011	4.779	33.039	28.179	36.786	32.370
April	5.565	5.395	5.185	29.943	29.576	34.190	33.681
May	5.237	6.698	6.569	28.548	34.071	32.833	38.163
June	5.145	7.773	7.484	26.872	36.759	30.841	41.000
July	5.053	8.635	8.446	26.071	37.917	29.107	41.524
August	5.219	8.768	7.937	31.401	36.071	34.784	40.227
September	5.978	8.753	7.788	34.986	35.122	38.318	38.339
October	5.733	7.950	7.557	31.890	33.656	36.190	36.977
November	5.131	7.881	7.647	31.972	30.588	36.568	33.898
December	4.813	.....	.....	29.088	.....	34.344	.....
Year	5.555	.....	.....	31.682	.....	35.962	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1932	1933	1932	1933	1932 Spot	1932 3 Mos.	1933 Spot	1933 3 Mos.
January	3.750	3.000	3.550	2.875	15.084	15.128	10.458	10.833
February	3.712	3.000	3.499	2.875	14.560	14.571	10.431	10.719
March	3.150	3.146	2.993	3.021	12.345	12.634	10.609	10.821
April	3.000	3.260	2.900	3.135	11.223	11.503	10.872	11.122
May	3.000	3.654	2.900	3.525	10.673	11.036	12.095	12.372
June	2.993	4.173	2.896	4.023	9.608	9.898	13.280	13.571
July	2.747	4.452	2.611	4.303	9.818	10.152	13.411	13.613
August	3.235	4.500	3.093	4.350	11.349	11.588	12.182	12.457
September	3.465	4.500	3.315	4.350	13.122	13.349	11.932	12.229
October	3.052	4.313	2.939	4.176	11.958	12.170	11.804	12.102
November	3.050	4.288	2.931	4.146	12.071	12.395	11.537	11.778
December	3.000	.....	2.877	.....	11.144	11.541	.....	.....
Year	3.180	.....	3.042	.....	11.913	12.164	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1932	1933	1932	1933
	Straits		Standard, Spot	
January	21.804	22.692	140.219	145.708
February	22.018	23.500	139.143	148.544
March	21.863	24.221	129.810	149.120
April	19.244	27.136	108.935	157.944
May	20.948	36.051	122.286	186.207
June	19.659	44.097	114.530	219.964
July	20.931	46.356	125.863	216.673
August	22.985	44.794	142.017	215.210
September	24.779	46.665	152.705	216.893
October	23.936	47.858	151.280	223.455
November	23.354	53.011	153.585	226.722
December	22.677	...	149.806	.....
Year	22.017	.....	135.848	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1932	1933	1932 Spot	1932 3 Mos.	1933 Spot	1933 3 Mos.
January	3.011	3.018	14.416	14.834	14.381	14.595
February	2.817	2.666	13.872	14.289	13.866	14.119
March	2.787	2.987	12.616	13.024	14.647	14.674
April	2.725	3.298	11.670	11.958	14.951	15.208
May	2.532	3.805	12.432	12.682	15.505	15.660
June	2.777	4.348	11.548	11.866	16.988	16.774
July	2.537	4.878	11.592	11.967	17.795	17.789
August	2.758	4.916	13.594	13.844	16.869	17.031
September	3.322	4.699	15.455	15.616	16.810	17.042
October	3.027	4.748	14.869	15.140	16.310	16.599
November	3.094	4.520	15.264	15.534	15.048	15.349
December	3.124	.....	15.209	15.347	.....	.....
Year	2.876	.....	13.545	13.842	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1932	1933	1932	1933
January	55.000	55.000	23.300	23.300
February	55.000	55.000	23.300	23.300
March	55.000	55.000	23.300	23.300
April	55.000	55.000	23.300	23.300
May	55.000	55.000	23.300	23.300
June	55.000	55.000	23.300	23.300
July	55.000	55.000	23.300	23.300
August	55.000	55.000	23.300	23.300
September	55.000	55.000	23.300	23.300
October	55.000	55.000	23.300	23.300
November	55.000	55.000	23.300	23.300
December	55.000.	.....	23.300	.....
Year	55.000	.....	23.300	.....

Aluminum in cents per pound, 99 per cent grade.
Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1932	1933	1932	1933	1932	1933
January	5.976	5.722	64.900	48.500	40.000	26.480
February	6.489	5.738	66.304	48.614	40.000	24.000
March	6.188	5.901	72.537	52.676	40.000	24.667
April	5.746	5.876	72.125	54.580	40.000	26.800
May	5.170	6.264	66.380	56.500	39.500	28.500
June	5.034	6.500	59.481	60.038	37.500	30.000
July	5.000	7.262	53.580	62.900	35.200	32.320
August	5.144	6.986	47.444	63.500	35.000	33.000
September	5.606	6.880	47.500	64.580	33.800	34.560
October	5.575	6.843	47.600	66.500	33.000	36.000
November	5.771	7.113	48.750	66.000	33.000	37.583
December	5.400	.....	48.500	.....	30.462	.....
Year	5.592	.....	57.925	.....	36.455	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1932	1933	1932	1933	1932	1933
January	16.00	14.50	15.00	14.00	15.50	14.50
February	15.68	14.50	14.68	14.00	15.18	14.50
March	15.50	14.50	14.50	14.00	15.00	14.50
April	15.50	14.50	14.50	14.00	15.00	14.50
May	15.50	15.42	14.50	14.42	15.00	14.92
June	14.85	16.00	14.35	15.00	14.75	15.50
July	14.56	16.50	14.00	15.50	14.50	16.00
August	14.50	17.00	14.00	16.00	14.50	16.50
September	14.50	18.00	14.00	17.00	14.50	17.50
October	14.50	18.00	14.00	17.00	14.50	17.50
November	14.50	18.00	14.00	17.00	14.50	17.50
December	14.50	.....	14.00	.....	14.50	.....
Year	15.01	.....	14.29	.....	14.79	.....

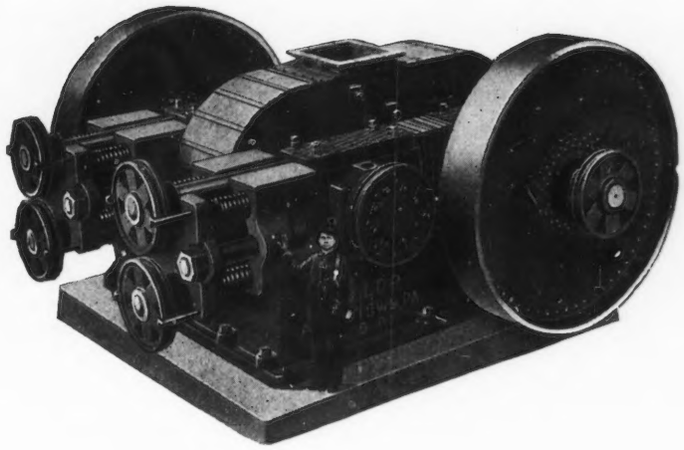
Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces

price basis of 4½c. per pound.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London prices for lead and zinc are the official prices for the first session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

New York silver quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, 925 fine. Sterling prices represent noon market demand.



MANY MAJOR MINES

Use Traylor Four-Tension Rod Crushing Rolls because these machines combine the characteristics that guarantee continuous and profitable operation:—

Strength that endures.
Reliability that banishes anxiety.
Capacity almost without limit.
Over thirty in use—largely 78" x 24".

Our Bulletin 1107 describes fully. Have our man bring one around or we'll mail it to you if you say so.

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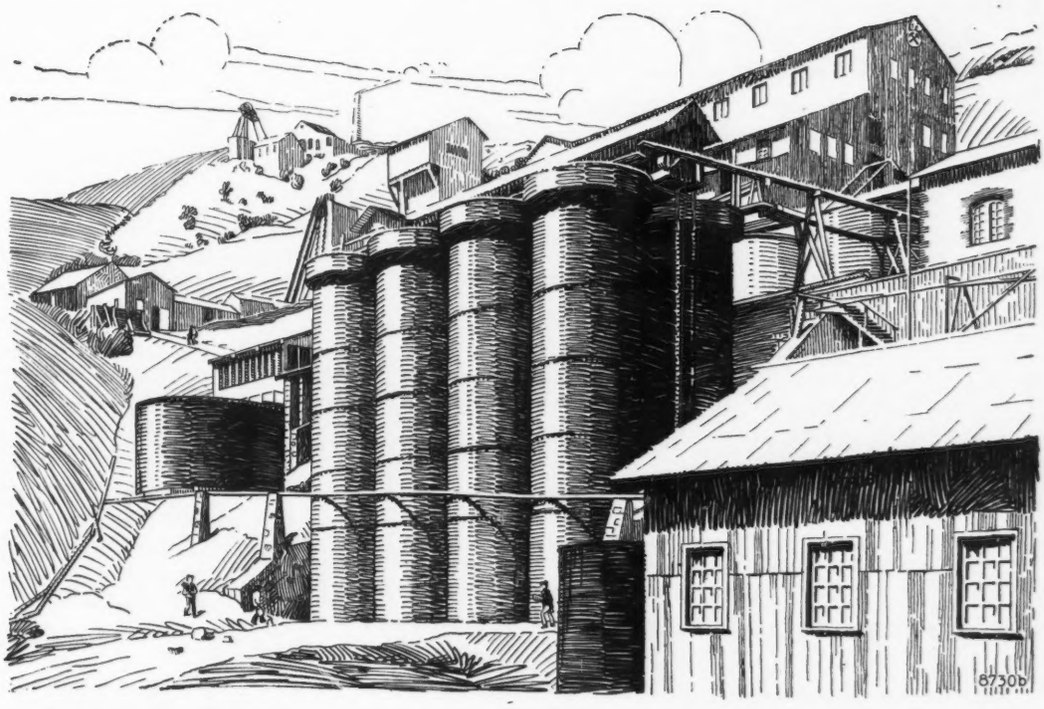

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IF you have a problem of removing iron, in any form, where detrimental to your product or for profitable iron recovery, consult the Stearns Testing Laboratory. Regardless of your past experience, it pays to submit your problems to specialists, because of new developments and research in magnetic separation. Write for bulletin "The House of Magnetic Magic" describing the service in detail, or send samples of your product for test.

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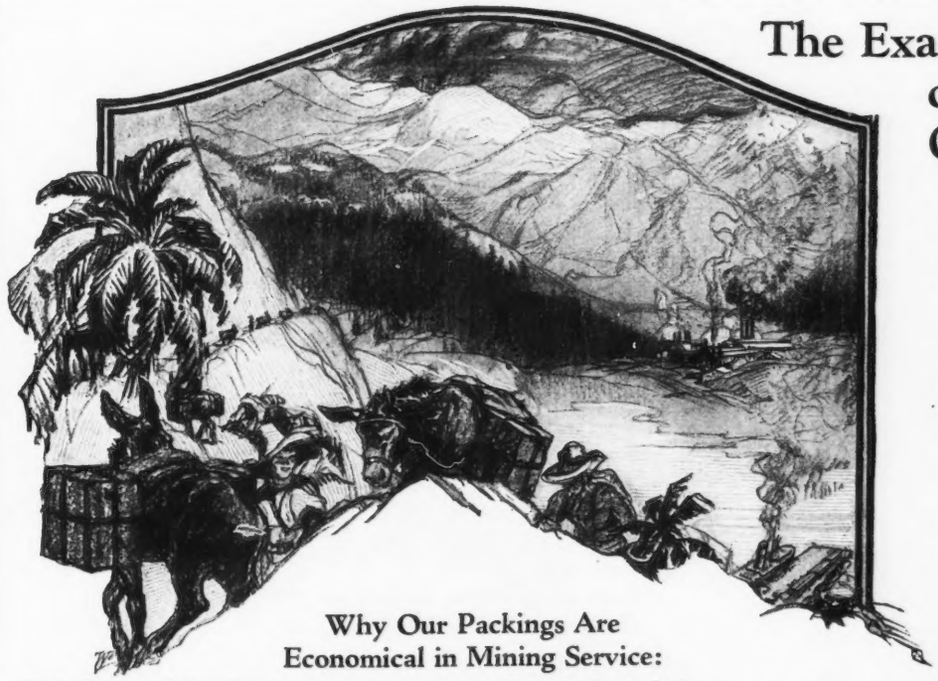

demand packings that give long service—because mining camps are usually located at points remote from sources of supply, the transportation of which is long and expensive. Therefore, it is important that the packing used is not affected by time and climate.

Why Our Packings Are Economical in Mining Service:

First—Because of their long-service quality, not so much packing is required.
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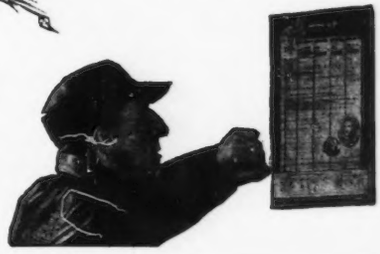

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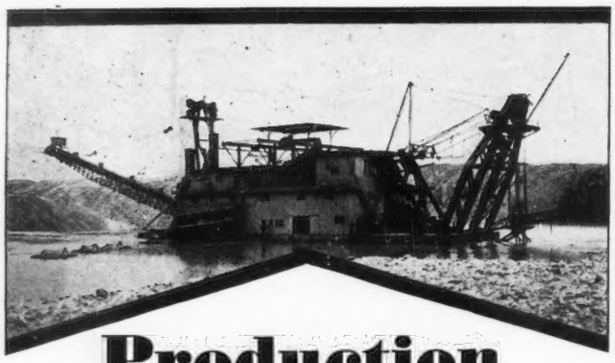

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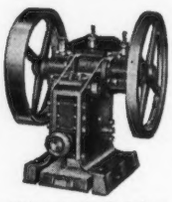
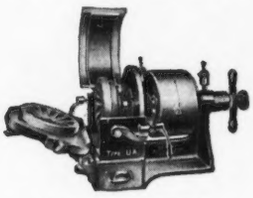


Chipmunk Crusher



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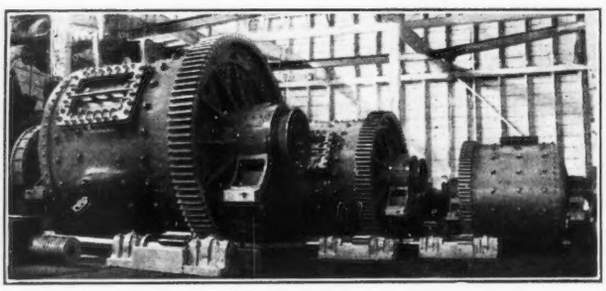

These Ribcone Ball Mills have everything. Of the low pulp line and rapid discharge type, these mills are inherently rapid grinders. The high permissible circulating load prevents over-grinding.

The mills shown above were designed to be used in conjunction with the Straub system of screen classifying and coarse gold recovery.

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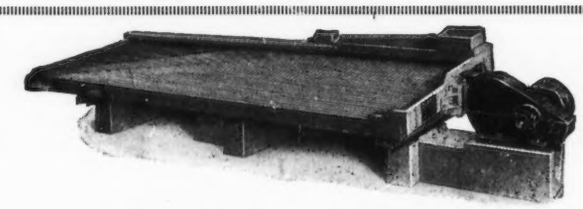

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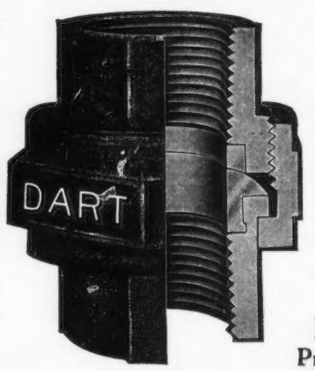

Two Bronze Seats machined and ground to a ball-joint, in combination with heavy pattern malleable iron pipe ends and nut is why Dart Unions gives years of satisfactory service.

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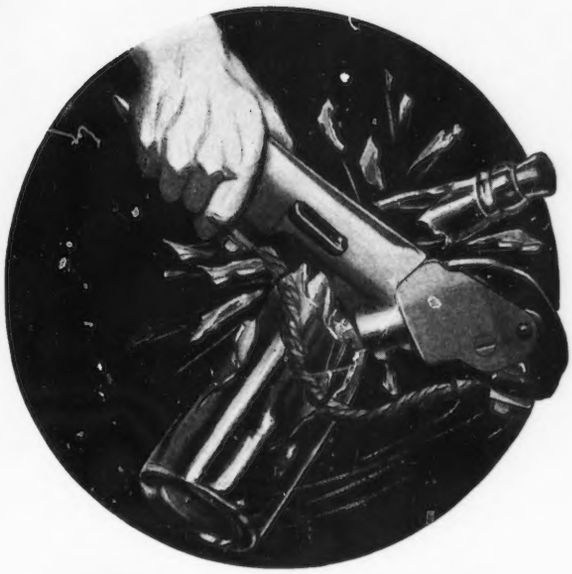

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with this new· · · · · · Shoe and Harp

WITHOUT changing the contour or basic design of the famous Universal Trolley Shoe, the contact surface of the new O-B Heavy Duty Shoe has been lengthened from 2 to 3¼ inches. A full one and one quarter inches of gliding surface have been added without adversely affecting operation through frogs and crossings. A 4-0 pigtail shunt also contributes materially to the handling of heavy amperages with ease. Try a few of these new Heavy Duty Shoes and Harps, Catalog No. 16686, on the toughest "hauls" in the mine. Then watch maintenance costs drop and "bottle-necks" disappear.

New O-B
Heavy Duty Shoe and Harp
The 3¼ inches of sliding contact surface along with the 4-0 pigtail shunt make this new device ideal for collecting heavy amperages on large locomotives. Order at least a few for trial. Catalog No. 16686.

1632-M

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A combination crusher, grinder and amalgamator. The Elliptic Roll strikes one hundred blows per minute and handles four inch material, reducing it to any desired mesh. The mill is built entirely of heat treated chrome steel and is unbreakable. Built for mule back transportation in capacities of five and ten ton.

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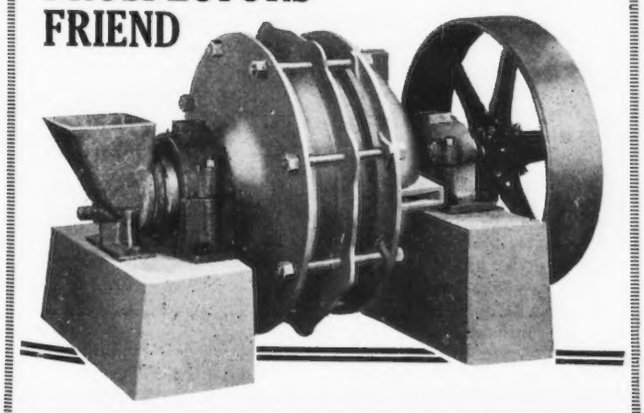

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A filter built to handle flotation concentrates and cyanide slimes. All pipes and valves are easily accessible; this flexibility makes it distinctive, quickly transported and assembled. The cast iron segments are easy to replace and unlike wooden types will not warp or leak. Built in 4 ft. and 6 ft. diameters. The 4 ft. x 2 ft. Denver Filter (left) will handle from 5 to 10 tons of concentrates per day. Immediate delivery from stock.

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For Digging—Stripping—Stock Piling
In digging and conveying materials distances up to 1500 ft., Sauerman machines are able to handle large tonnage at low cost.
Sauerman Slackline Cableways are in a class by themselves for work where materials must be lifted from under water and conveyed to an elevated bin, screening plant or storage pile.
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3—Allis-Chalmers Blake-type Jaw Crushers, size 10-in.x20-in.
2—Llewellyn Blake-type Jaw Crushers, size 8-in.x12-in.
1—Telsmith Gyratory Reduction Crusher, size No. 32.
2—Allis-Chalmers style "K" Gyratory Crushers, size No. 5.
1—Allis-Chalmers style "K" Gyratory Crusher, size No. 8.

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2—No. 64½ Marcy Ball Mills complete with liners.
2—8-ft.x36-in. Hardinge Conical Ball Mills, complete with liners.
1—6-ft.x36-in. Hardinge Conical Ball Mill complete with liners.
1—6-ft.x22-in. Hardinge Conical Ball Mill complete with liners.
2—6-ft.x16-in. Hardinge Conical Ball Mills complete with liners.
2—4½-ft.x16-in. Hardinge Control Ball Mills complete with liners.
1—4-ft.x4-ft. New "Eimco" Ball Mill complete with liners.
1—5-ft.x5-ft. New "Eimco" Ball Mill complete with liners.
1—6-ft.x12-ft. Marcy Rod Mill complete with liners.

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3—Dorr Model "C" Simplex Classifiers, size 2-ft. 3-in.x14-ft. 8-in.
3—Dorr Model "C" Duplex Classifiers, size 4-ft. 6-in.x14-ft. 8-in.
1—Dorr Model "C" Duplex Classifier, size 6-ft.x20-ft.
1—Dorr Bowl Classifier, type "D5DB", size 8-ft.x31-ft. 8-in. and 18-ft. Bowl.
2—45-in. Akins Classifiers.
2—54-in. Akins Classifiers.

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3—14-ft.x6-ft. Dorr Thickeners complete.
2—20-ft.x8-ft. Dorr Thickeners complete.
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2—35-ft.x12-ft. Dorr Thickeners complete.
3—40-ft.x10-ft. Dorr Thickeners complete.
1—50-ft.x12-ft. Dorr Thickener complete.
1—85-ft.x12-ft. Dorr Thickener complete.
3—Dorr Agitators comp., size 30-ft.x20-ft.
3—Dorr Agitators comp., size 20-ft.x16-ft.
3—Dorr Agitators comp., size 16-ft.x14-ft.
6—Propeller-type Agitators, sizes for 12-16-20-30-ft. tanks.

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2—Oliver Continuous Drum type Filters, complete, size 14-ft.x14-ft.
3—Oliver Continuous Drum type Filters, complete, size 10-ft.x10-ft.
1—Oliver Continuous Drum type Filter, complete, size 12-ft.x6-ft.
2—Oliver Continuous Drum type Filters, complete, size 6-ft.x6-ft.
1—Oliver Continuous Drum type Filter, Acidproof, size 5-ft.x4-ft.
2—American Disc Filters, 4-ft. x 1 Disc.
1—American Disc Filter, 4-ft. x 2 Disc.
1—American Disc Filter, 4-ft. x 4 Disc.
1—American Disc Filter, 6-ft. x 2 Disc.
1—American Disc Filter, 6-ft. x 3 Disc.
1—American Disc Filter, 6-ft. x 4 Disc.
All complete with necessary vacuum equipment.

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5—Jeffery Electric Trolley Wire Locomotives, 2½-ton, 24-in. gauge.
2—Jeffery Electric Trolley Wire Locomotives, 4-ton, 18-in. gauge.
1—Baldwin-Westinghouse Trolley Type Locomotive, 13-ton, standard gauge.
1—Goodman Battery Locomotive, 2½-ton, 18-in. gauge.
1—Mancha Battery Locomotive, 5-ton, 24-in. gauge.
15—85-cu.ft., 24-in. gauge heavy duty Granby-type Ore Cars, roller bearings.
16—24 cu.ft., 18-in. gauge Sanford-Day Rocker Dump Ore Cars.
50—14-16 cu.ft., 18-in. gauge Mine Ore Cars.

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2—5-ft.x4-ft. Standard—Steel Lined.
2—4-ft.x3-ft. Standard—Steel Lined.
1—3 ft.x3-ft. Standard—Steel Lined.
1—3-ft.x2½-ft. Standard—Steel Lined.
2—30-in.x24-in. Standard—Steel Lined.

BALL MILLS—(Used)

1—No. 75 Marcy Ball Mill.
1—64½ Marcy Ball Mill.
1—7x6-ft. Allis-Chalmers Ball Mill.
1—6x12-ft. Allis-Chalmers Ball Mill.
1—10-ft.x48-in. Hardinge Ball Mill.
3—8-ft.x30-in. Hardinge Ball Mills.
2—4½-ft.x16-in. Hardinge Ball Mills.
2—3x4-ft. Colorado I.W. Ball Mills.

FILTERS—DISC TYPE

2—14-ft. 4-disc American Filters.
2—12-ft. 4-disc American Filters.
1— 6-ft. 6-disc American, 2 compartment.
2— 6-ft. 4-disc American, 2 compartment.
1— 6-ft. 3-disc American, 2 compartment.
2— 4-ft. 4-disc American, 2-compartment.
1— 4-ft. 3-disc American, 2-compartment.

FILTERS—DRUM TYPE

2—10-ft.x16-ft. Rotary Drum Type Filters.
2—10-ft.x12-ft. Rotary Drum Type Filters.
4— 8-ft.x12-ft. Rotary Drum Type Filters.
2— 8-ft.x10-ft. Rotary Drum Type Filters.
2— 8-ft.x 8-ft. Rotary Drum Type Filters.
1— 6-ft.x 6-ft. Rotary Drum Type Filter.
2— 6-ft.x 4-ft. Rotary Drum Type Filters.

FILTERS—DRUM TYPE (continued)

1— 4-ft.x 4-ft. Rotary Drum Type Filter.
1— 4-ft.x 1-ft. Rotary Drum Type Filter.
1— 6-ft.x 8-ft. Dorr Continuous Filter

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1—75 hp. Fairbanks-Morse Diesel Electric, 3 ph., 60 cy., 2300 v.
2—300 hp., Fairbanks-Morse Diesel Electric, 3 ph., 60 cy., 2300 v.
1—1000 hp. Busch-Sulzer Diesel Electric, 3 ph., 60 cy., 2300 v.
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1—150 kw. Murray Iron Wks.-G. E. Engine Generator Set, 3 ph., 60 cy., 2300 v.
2—1000 kva. Pelton-G. E. Hydro-Elec. 3 ph., 60 cy., 2300 v.
1—300 kva. Trump-G. E. Hydro-Elec. 3 ph., 60 cy., 2300 v.
1—150 kva. Globe-G.E. Hydro-Elec. 3 ph., 60 cy., 440 v.

CYANIDE EQUIPMENT

1—6-ft.x21-ft. Duplex Classifier.
4—54-in.x16-ft. Duplex Classifiers.
3—45-in. Akins Classifiers.
1—36-in.x14-ft. 6-in. Simplex Classifier.
5—27-in.x14-ft. 6-in. Simplex Classifiers.
4—15-in.x12-ft. Simplex Classifiers.
40—Thickener Mechanisms, all sizes, 10 to 80-ft. Diameters.
20—Agitator Mechanisms, all sizes, 10 to 40-ft. Diameters.
15—Diaphragm Suction Pumps, 2-in., 3-in., 4-in., Simplex, Duplex, Triplex.

WESTINGHOUSE PORTABLE AIR COMPRESSOR

Gas Engine Driven

10—125 cu.ft. per min. Capacity.
4—240 cu.ft. per min. Capacity.
6—320 cu.ft. per min. Capacity.
9—330 cu.ft. per min. Capacity.

COMPLETE 25-TON FLOTATION PLANT

(Ready-to-Ship)

1—3-ft.x6-ft. Grizzly.
1—8-in.x8-in. Universal Jaw Crusher with 7½ hp. Motor, V-Belt Drive.
1—20-in.x24-in. Ore Bin Gate.
1—Plunger Type Ore Feeder.
1—4½-ft.x16-in. Hardinge Ball Mill with 25 hp. Motor, V-Belt Drive and Ball Charge.
1—27-in.x24-in. Pierce Amalgamator.
1—27-in.x14-ft. Dorr Rake Classifier.
1—Duplex Oil Reagent Feeder.
1—Dry Reagent Feeder.
1—4-cell 15-in. Denver Fahrenwald Sub-A Motor Driven Flotation Machine.
1—Wilfley Pilot Table, Motor Driven.
1—10-in. Thickener with Tank.
1—4-ft.x1-ft. Oliver Filter with Vacuum Equipment.
1—7½ hp. Motor for Thickener and Filter.

Total Weight, approx.....47,750 lbs.
Price, complete F.O.B. Denver.....$5,475.00

Send for our latest Stock List, now ready for mailing.

THE MORSE BROS. MACHINERY & SUPPLY COMPANY

P. O. Box 1708 DENVER, COLORADO, U. S. A. 2900 BROADWAY

1 to 50 Tons Capacity

Automatics!

(Dump 20 a minute without labor!)

The Quality of Our Wheels is Superb

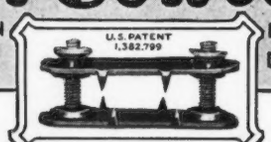
(Try us on Repair Wheels or Trucks)

Other types of Ore Cars

Sanford-Day Iron Works, Knoxville, Tenn.

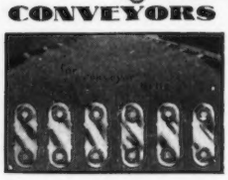
Tight Butt Joints

COMPRESSION PRINCIPLE



FAMED FOR DURABILITY

CONVEYORS



ELEVATORS

THE recessed plates embed in the belt and compress it instead of pulling against the bolt holes. This provides great surplus strength. It equalizes the pull throughout the plies. Keeps belt ends intact avoiding trouble. FLEXCO HD Belt Fasteners are in extensive use throughout many industries, giving long reliable service wherever tight butt joints are desired. Made in steel and in monel metal. Sold by jobbers and belting houses in 5 sizes. Recommendations supplied gladly.

FLEXIBLE STEEL LACING COMPANY

4635 Lexington Street Chicago, Illinois

In England at 135 Finsbury Pavement, London, E. C. 2

FLEXCO

HD

Belt Fasteners

MOHAWK MINING COMPANY

NOTICE OF SALE

NOTICE IS HEREBY GIVEN that all the remaining lands and interests in lands of the Mohawk Mining Company, consisting generally of approximately 15,000 acres, including its mineral lands, the Michigan Mine at Rockland, Michigan, having one shaft equipped and in condition to resume mining on short notice; the Mass Mine at Mass City, Michigan; the Wolverine Mine at Kearsarge, Michigan; the Mohawk Mine at Mohawk, Michigan; Three stamp mill sites, approximately ten million feet of merchantable timber, and approximately 5600 acres of land suitable for farming purposes, and a quantity of mining and office supplies and employees' dwellings, are hereby offered for sale.

More detailed information of the property to be sold may be had by application to the office of the company at 15 William Street, New York City, or at its office at Mohawk, Keweenaw County, Michigan.

Terms of sale are ten per cent. of purchase price on the signing of a contract of sale and purchase and balance on delivery of deeds thirty days later. Offers will be received at either office of the company.

MOHAWK MINING COMPANY
By F. G. Heumann, *Secretary*

FOR SALE

GOLD DREDGE

Used six cubic foot, close connected bucket, electric powered gold dredge capable of digging 55 feet below water line, in good condition and within a short distance of railroad.

FS-421, Eng. & Min. Journal
520 No. Michigan Ave.,
Chicago. Ill.

FOR SALE

ENGINE GENERATOR SET

260 amp., 240 v., 60 cy., 2 ph., 277 r.p.m. Allis-Chalmers—Ideal—14 in. bore, 13 in. stroke. Complete with belt driven exciter and switchboard.

STEAM HOISTS

Lidgerwood—16 in. bore, 18 in. stroke, drum 62 in. dia., 64 in. wide.
Lambert—14 in. bore, 16 in. stroke, drum 62 in. dia., 64 in. wide.

PUMP

Triplex vertical—Deane—Size 13x12, arranged for belt drive from steam engine —Armington 10 in. bore, 12 in. stroke.

STEAM PUMPS

2—Worthington, size 6x4x6.
1—Kelly Water Tube Heater.

D. C. GENERATOR

Garwood Elec. Co., 10 kw., 110 v., 450 r.p.m., arranged for belt drive. Complete with switchboard.

GOODWIN-GALLAGHER SAND & GRAVEL CORP.
Port Washington, L. I.
Phone: Port Washington 92

Get it from

KNAPP

Save Money — Save Trouble

GUARANTEED REBUILT

VALVES

3—36" Pelton gate valves for 900' operating head; made of cast steel, single disc type. bronze mounted, rising stem, ball bearing, hand operated, weight 24,700 lbs.

WHIM

1—Horse whim, drum 22" dia. x 14" face x 2¾" flanges.

WINCH

1—Double geared iron frame hand winch, capacity 3 tons on a single line.

AGITATORS

3—24" Devereaux type agitators.

AMALGAM PLATES

1—Plate 2'x4½', 5-lb. copper; 1-oz. silver.
3—Plates 4'x5', 4-lb. copper; 1-oz. silver.
3—Plates 4'x5', 4-lb. copper; 1-oz. silver.
8—Plates 4'x4', 4-lb. copper; 1-oz. silver.
6—Plates 5'x5', 5-lb. copper; 1-oz. silver.

ANVIL

1—Steel anvil, weight 225 lbs.

ASSAY CRUSHERS

1—4x6 Dodge, belt driven.
1—3x4 Dodge, belt driven.
1—3x3 Braun laboratory crusher.
1—2x4 Calkins laboratory crusher.
1—Braun pulverizer, type UA.

BALLS (GRINDINGS)

WE CARRY IN STOCK BOTH FORGED CHROME STEEL AND CAST IRON GRINDING BALLS.

Check the list! If what you want is there —get our surprisingly low price. If you need equipment not listed, you'll find it in our complete stock list. Write for it.

J. E. KNAPP CO.
593 Market Street, San Francisco, Calif.
Telephones: Garfield 4783 & 4784

FOR SALE

Thousands of items of good used equipment consisting of Jaw, Gyratory and Roll Crushers; Ball, Tube and Hardinge Mills; Rotary Kilns and Dryers; Dorr and Oliver Thickeners and Filters; Classifiers; Sweetland and all types of Filter Presses, etc. Shops at Newark, N. J., cover six acres.

CONSOLIDATEDPRODUCTSCOMPANY, Inc.
13-19 Park Row, New York City

DEALERS

IN ENGINEERED MACHINERY
—DESIGNERS AND BUILDERS OF AERIAL TRAMWAYS

1—6x6-ft. Allis-Chalmers Ball Mill.
1—Complete 2-Mile Aerial Tramway.
1—1500-cu.ft. Ingersoll-Rand Two-Stage Air Compressor.

Write us when you need better machinery.

DACHNER

Machinery and Engineering Co.
116 New Montgomery, San Francisco, Cal.

Additional Equipment Advertising on page 16

SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or RESALE

UNDISPLAYED—RATE PER WORD:
(Domestic Edition)

Positions Wanted, 5 cents a word, minimum $1.00 an insertion, payable in advance.
Positions Vacant and all other classifications, 10 cents a word, minimum charge $2.00.
Proposals, 40 cents a line an insertion.

INFORMATION

Box Numbers in care of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads. Replies forwarded without extra charge.
Discount of 10% if one payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:
(Domestic Edition)

1 inch $6.00
2 to 3 inches..... 5.75 an inch
4 to 7 inches..... 5.50 an inch
Rates for large spaces, or yearly rates, on request.
An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page. E.M.J.

Copy for New Advertisements for the January Issue received until Dec. 26th.

EMPLOYMENT SERVICE

SALARIED POSITIONS, $2,500 to $25,000. This thoroughly organized advertising service of 24 years' recognized standing and reputation carries on preliminary negotiations for positions of the caliber indicated, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by a refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If you have actually earned over $2,500, send only name and address for details. R. W. Bixby, Inc., 264 Delward Bldg., Buffalo, N. Y. (E. M. J.)

POSITIONS WANTED

ASSAYER—Chemist, 41, single, 18 years' experience mill, mine and smelter. Latin America and U. S. A. experienced blast furnace operator, desires connection with reliable outfit, preferably Latin America. Fluent Spanish. PW401, Engineering and Mining Journal, 330 West 42d St., New York City.

GRADUATE mining engineer, 27, experienced in mining and related construction. Some chemical experience. Go anywhere. Salary secondary consideration. References. PW-427, Engineering and Mining Journal, 330 West 42d St., New York City.

EXPERIENCED mining engineer, technical graduate, age 31, 8 years' underground and open pit mining and mine development. PW-418, Engineering and Mining Journal, 330 West 42d St., New York City.

METALLURGIST ENGINEER, A.I.M.E., 25 years' experience, foreign and U. S. A. Designing, erection, and operation of free milling and cyanide plants; flotation experience. Capable of taking full charge of small properties. References. Go anywhere. PW-424, Engineering and Mining Journal, 883 Mission St., San Francisco, Calif.

MINING ENGINEER, superintendent or assistant superintendent; technical graduate, 17 years' experience, mining, milling, design and construction. Capable taking charge development, operation or remodeling plant for increased production and efficiency. Active, industrious. Excellent references. PW-415, Engineering and Mining Journal, 520 No. Michigan Ave., Chicago, Ill.

SALESMAN AVAILABLE

AMERICAN SALES ENGINEER, two years' experience in Russia, wishes position selling mining, milling and allied industries machinery and equipment. Thoroughly experienced. SA-428, Engineering and Mining Journal, 883 Mission St., San Francisco, Calif.

BUSINESS OPPORTUNITIES

Claims of Proven Merit

discovered by well known mining man to be sold in well mineralized zone. Full particulars apply Capt. A. Johnson, Boston Creek, Canada.

Mine Owner

For an option to purchase a sizable block of your stock, you can secure the services of a real operating manager, a practical and graduated mining engineer who can get results. This engineer is an expert at finding and developing ore bodies. Your requirements solicited. BO-422, Engineering and Mining Journal, 330 West 42d St., New York City.

A Few More Members

Wanted by syndicate prospecting for and developing gold and other mineral deposits. Syndicate now composed of two geologists, an engineer, a lawyer, and a business executive. BO-425, Engineering and Mining Journal, 520 No. Michigan Ave., Chicago, Ill.

Raising Capital

Inquiries solicited from corporations interested in raising capital through marketing corporate securities. The Brookworth Co., Inc., 110 East 42d St., New York, N. Y.

Quicksilver Mine For Sale

One of the largest producers of mercury in America is offered to responsible operators.

This property is now operating at a substantial profit.

Price, terms and full reports will be supplied reliable persons.

Mills Bldg. San Francisco

H. W. GOULD & Co.

CAPITAL WANTED

To open up a likely GOLD property in rich mineral district, 1300 acres, 800 of it patented, three miles from Deadwood and natural gas mains, one mile from State Highway and electric power line, plenty of timber and water, ideal mill site, has the makings of a big, dividend-paying mine. Can be optioned on most liberal terms. No stock selling scheme entertained.

WM. A. REMER
DEADWOOD, SOUTH DAKOTA

GOLD MINING PROPERTY FOR SALE

Location—Nicaragua. Stopped operation in 1920 on account of high cost of supplies and labor due to War conditions. Mine in proven Gold Belt. Owner will sell cheap. Complete details to responsible parties. Address

BO-423, Engineering and Mining Journal
520 No. Michigan Ave., Chicago, Ill.

CALIFORNIA PLACER MINE FOR SALE

Equipped for hydraulics, rigged for mining, superior water rights, high pressure. Six claims, part dredging ground, located in famous gold district of Northern California. Mine hardly open—3 acres worked out to demonstrate. Unusual proposition for practical mining men properly financed. No Agents. Owner.

GALLIA MINE
320 Market St. San Francisco

THE TONOPAH MINING CO. OF NEVADA

EXPLORATION DEPARTMENT

Prospects of Merit Financed

H. A. JOHNSON
Supt. in Charge of Operations
Tonopah, Nevada

FOR SALE

CINNABAR ORE

Two tracts with rich Cinnabar (Quicksilver) Ore deposits in the new Arkansas field. Write

ACME PRODUCTS COMPANY
Nashville, Arkansas

GOLD PROPERTY WANTED

Advertiser desires to secure for financial interests substantial gold property having indications of developing into a mine of considerable magnitude. Mail complete details.

BO-407, Engineering & Mining Journal
520 No. Michigan Ave., Chicago, Ill.

WANTED

4-Ft. Symons Gyratory Crusher

Must be in absolutely first-class condition, and price given in reply.

W-426, Engineering and Mining Journal
330 West 42d Street, New York City

For Sale

WATERWHEELS and TURBINES

NEW AND USED

HYDRO-ELECTRIC PLANTS

H. W. MONTAGUE
525 Howard St., San Francisco

HYDRAULIC PIPE, GIANTS, WATER LIFTERS, ELEVATORS

500 ft. 26 ft., 28 in. Spiral Riveted Pipe.
800 ft. 20 in. Spiral Riveted Pipe.
1,000 ft. 14 in., 12 in., 8 in. Spiral Riveted Pipe.

Offered subject to prior sale f.o.b. Philipsburg, Montana.

AMERICAN GEM MINING SYNDICATE
Security Bldg., St. Louis, Mo.

PUMPS

Byron-Jackson 2-stage split case brass fitted centrifugal pump, 10 in. suction, 8 in. discharge. Direct connected to 400-hp. Gen. Elec. 3 ph., 60 cy., 2200 v. motor, with starter. Capacity: 3000 gals. per min. against 330 ft. head. Practically new at one third new price.

H. T. NEAL MACHINERY COMPANY
58 Sutter Street, San Francisco.

Additional For Sale Advertisements on pages 15, 14 and 13

make AIR DO MORE *and cost less*

Many mines all over the world today are speeding up their progress with the Gardner-Denver Model D-89 Drifter. Tough tests show it to be the fastest 3½" bore drill—and the lowest in air consumption. Because it is so free from vibration, it is a stranger to the drill doctor. And it is far easier to operate because of its stream-line design.

The Gardner-Denver DS-6 Sharpener, too, is making firm friends these days. It has maximum capacity in handling the largest sections of drill steel. The area of the tandem clamping pistons combined is greater than the corresponding area of any other sharpener of equal size. All scale is removed from the dies by an automatic scale blower. Simplicity of operation is assured by the single-lever control.

Write for free bulletins on the Gardner-Denver D-89 Drifter and DS-6 Sharpener.

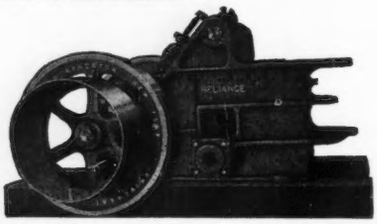
GARDNER-DENVER COMPANY · QUINCY, ILLINOIS

GARDNER-DENVER

"GAYCO-RELIANCE"

Gives Better Air Separation— At New Low Cost

ALTHOUGH air separation is not new, the patented centrifugal action of the New Model "Gayco" gives a more uniform product, greater capacity, cleaner tailings and higher efficiency than is possible with any other air separator. It can be easily adjusted to deliver products of any desired screen analysis from 60 to 325 mesh, and when once adjusted the fineness is not affected by variations of speed or rate of feed. Adjustment for any product is always the same and can be noted and returned to at any time. Power costs are very low, and repair costs are practically nothing. Write, or fill out coupon for catalog containing detailed information and diagrams of construction.



UNBREAKABLE CRUSHERS

The first Reliance All-Steel Crusher—built more than 20 years ago—is still in operation; and has been in constant use since 1903. If you want long-continued, satisfactory work, and low cost of maintenance you will be interested in Reliance specifications and prices. Nine standard sizes.

RUBERT M. GAY
DIVISION OF
UNIVERSAL ROAD MACHINERY CO.
Sales office: 114 Liberty St., New York, N.Y. Factory: Kingston, N.Y.

Also Manufacturers of:

Bucket Elevators	Heating Kettles	Sand, Gravel Spreaders
Bin Gates	Pulverizers	Wash Boxes
Belt Conveyors	Rock Crushers	Complete crushing, screening and washing plants for quarried stone or sand and gravel
Coal Breakers	Revolving Screens	
Car Unloaders	Street Sweepers	
Chip Spreaders	Scarifiers	
Feeders	Storage Bins	
Grizzlies		

RUBERT M. GAY
Division of
UNIVERSAL ROAD MACHINERY CO.
Sales office: 114 Liberty St., New York, N.Y. Factory: Kingston, N.Y.

Gentlemen:
Please send me further details and specifications on the equipment checked below:

.....GAYCO RELIANCE AIR SEPARATORS
.....RELIANCE CRUSHERS
.....(Other equipment listed above)

Name ..... Title .....
Address .....

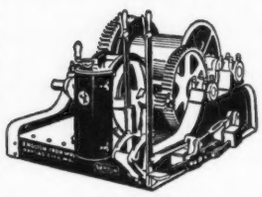
DOWN

Down go blasting costs when the right explosives are correctly used. Talk it over with Hercules and see what can be done about getting your blasting costs down.

HERCULES POWDER COMPANY
INCORPORATED
Wilmington, Delaware

A-35

. . . HOISTS . . .



Type MS
Friction Drum Electric Hoist

Frames of Hoist are fabricated Steel, strongly riveted and rigidly braced, practically indestructible; lighter than cast iron.
Sizes, loads 4,000 to 6,000 pounds.
Drum diameters up to 30".
In these Hoists is incorporated, the best in engineering practice.
Bulletins upon request.

English Bros. Machinery Co.
Manufacturers
KANSAS CITY, MO.

Engineering & Mining Journal

readers study these pages for news of what your product can do for them.

¶ **"Call on" these readers of over 30,000 throughout the world regularly. . . .**

¶ **They will welcome your sales messages for them in these pages. . . . . .**

It Will Pay You to Put These TIMKEN ROCK BIT ECONOMIES *Into Effect in Your Mine Now*

Note that the steel does not bottom in the bit—an important reason why the threads are not subjected to wear or damage.
Note how the bit is driven into the rock—against a solid upset shoulder on the steel. No strain on threads.

Timken has made the removable bit a practical reality. Timken Bits eliminate all re-sharpening and incidental expense including transportation of steels to and from the work, the operation of costly re-sharpening equipment and the necessity for a large investment in steels. Skips are kept free for hoisting ore at all times.

But that is only one side of the Timken Bit economy picture. The other is *more footage per bit* through the use of Timken fine-grained electric furnace steel, scientifically heat treated.

It means that you will get more holes per day at less cost per hole—in any type of rock.

No bit is better than the steel from which it is made. That's where Timken steel-making experience and facilities come in.

The Timken Bit is not an experiment but a thoroughly tested and proved product. Timken Rock Bit economies and other advantages are being demonstrated over and over on some of the toughest rock drilling jobs in the country. You can begin to save with Timken Bits immediately.

No need to discard your old steels. They can be converted for Timken Bits at small cost. Write for full information. Mention type of rock drilled and number of jack hammers or drills in use.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN BITS

INTERNATIONAL SMELTING COMPANY

New York Office: 25 Broadway

Purchasers of

GOLD, SILVER, COPPER, LEAD
LEAD-ZINC ORES and CONCENTRATES

Ore Purchasing Departments:

818 Kearns Building, Salt Lake City, Utah—Miami, Arizona

ANACONDA
from mine to consumer

Copper Smelter: Miami, Arizona
Lead and Copper Smelters: International, Utah
Custom Lead-Zinc Concentrators: International, Utah; Rico, Colo.
Refineries: Raritan Copper Works, Perth Amboy, N.J., and International Lead Refining Company, East Chicago, Ind

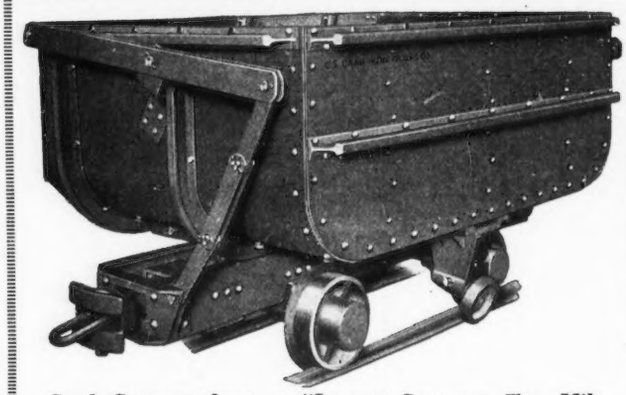
BENDELARI DIAPHRAGM JIGS

FOR EVERY GRAVITY SEPARATION

FROM SAVING PLACER GOLD TO CLEANING ONE INCH GRAVEL

F. N. BENDELARI
JOPLIN, MO.

CARD CARS



Card Cars produce at "Lowest Cost per Ton Mile Haul" because of
simplicity in design
rugged construction
41 years' experience

Write for Catalog E.

Make your next replacements with Card Semi-Steel Heat-Treated Wheels. To any unpatented design; 1 or 1,000.

C.S. Card Iron Works Co.
Denver, Colorado.

Gold prices are up

BUT are you getting
MAXIMUM PRICES?

INCREASED gold prices make modern, up-to-requirement assay furnaces an absolute necessity to maximum profits. DFC Assay Furnaces build profits two ways: (1) by holding assay costs to a minimum, (2) by giving you thoroughly reliable assays upon which you can make settlements.

Their fast, efficient operation prevents costly delays.

DFC ASSAY FURNACES

like DFC Metallurgical Clay Goods and other DFC supplies and equipment for the mining industry, SET THE STANDARD the world over.

AVAILABLE FOR BURNING GAS; GASOLINE; COAL; OR OIL UNDER LOW, MEDIUM OR HIGH PRESSURES

Write or wire for complete information.

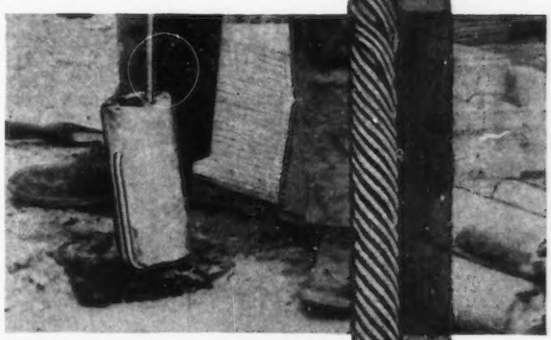
THE DENVER FIRE CLAY COMPANY
DENVER DFC COLO. U.S.A.
BRANCHES AT SALT LAKE CITY. EL PASO. AND NEW YORK

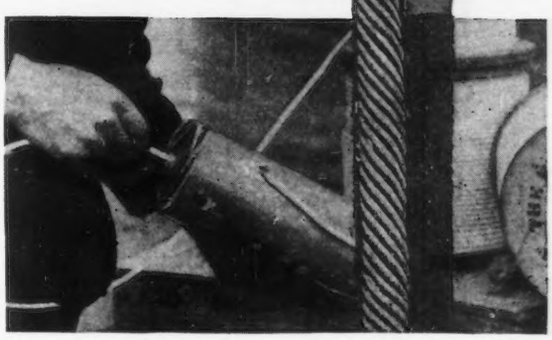
Get *more work* out of your *Explosives*

Extra powerful detonation, not only at the primer cartridge, *but throughout each hole,* is one of the reasons why operators are extending their use of Cordeau-Bickford Detonating Fuse. Its positive action and ease of hookup have made the giant blast practicable — and profitable; yet these are also good reasons why "Cordeau" can be employed profitably in smaller blasts.

There is a new technique in blasting that will interest you. It is fully explained in the Cordeau book — free. The Ensign-Bickford Company, Simsbury, Conn.

CB24





CORDEAU BICKFORD
DETONATING FUSE

ALPHABETICAL INDEX TO ADVERTISERS

This index is published as a convenience to the reader. Every care is taken to make it accurate, but *Engineering & Mining Journal* assumes no responsibility for errors or omissions.

*Where an asterisk precedes manufacturers' name, more detailed information may be found in the *1932 edition of Metal Quarry Catalogs*, the combined catalogs of manufacturers of mining, milling, smelting and refining equipment.

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NICHOLS HERRESHOFF FURNACE

for revivifying Fuller's Earth or other filtering media

THE GREAT number of Nichols Herreshoff Furnaces in use testifies to their economy and efficiency in the revivification of Fuller's Earth and kindred filtering media.

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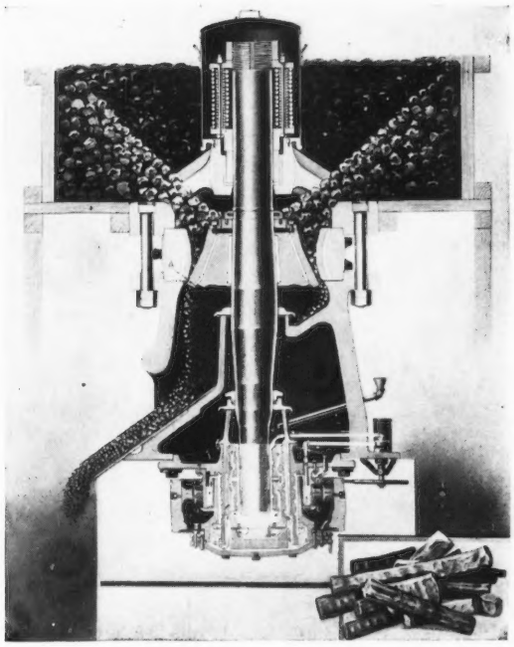

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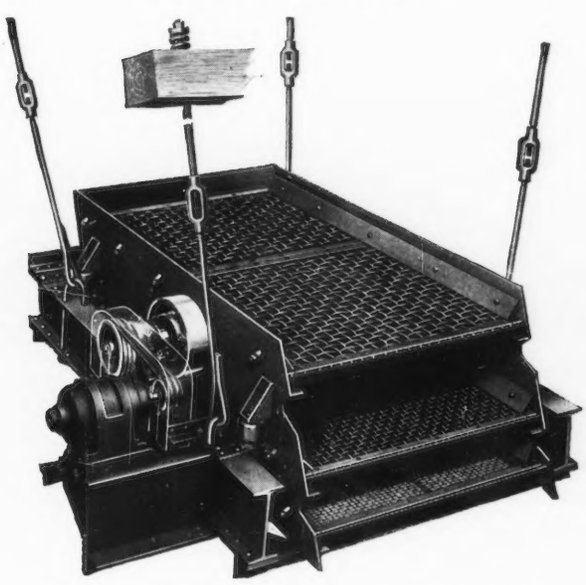
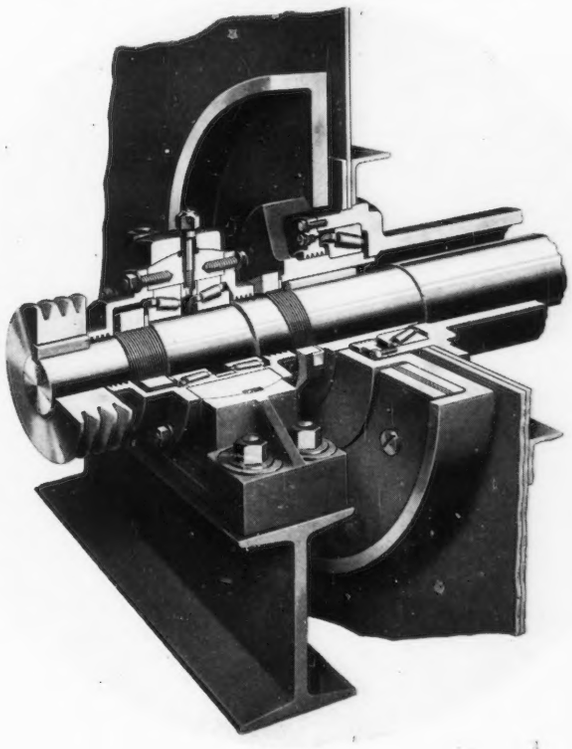
Sieving test on glacial gravel crushed at the rate of 18 tons per hour, with No. 19 crusher set to ⅛ in., and using less than 15 hp., follows:

Minus ⅜"	100 %
Plus 3 mesh	21½%
Minus 3 —Plus 4	17 %
Minus 4 —Plus 14	36½%
Minus 14—Plus 48	15 %
Minus 48—Plus 100	4 %
Minus 100	5½%





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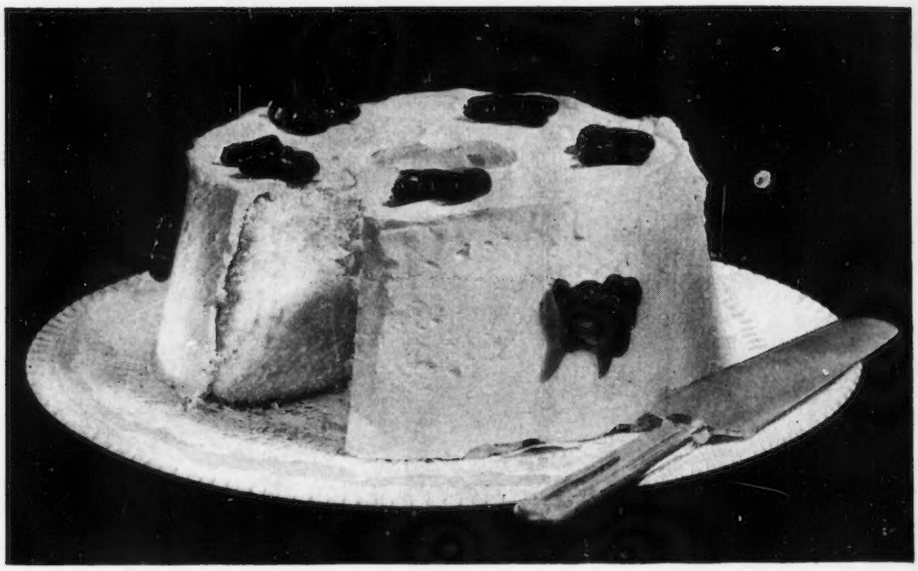

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